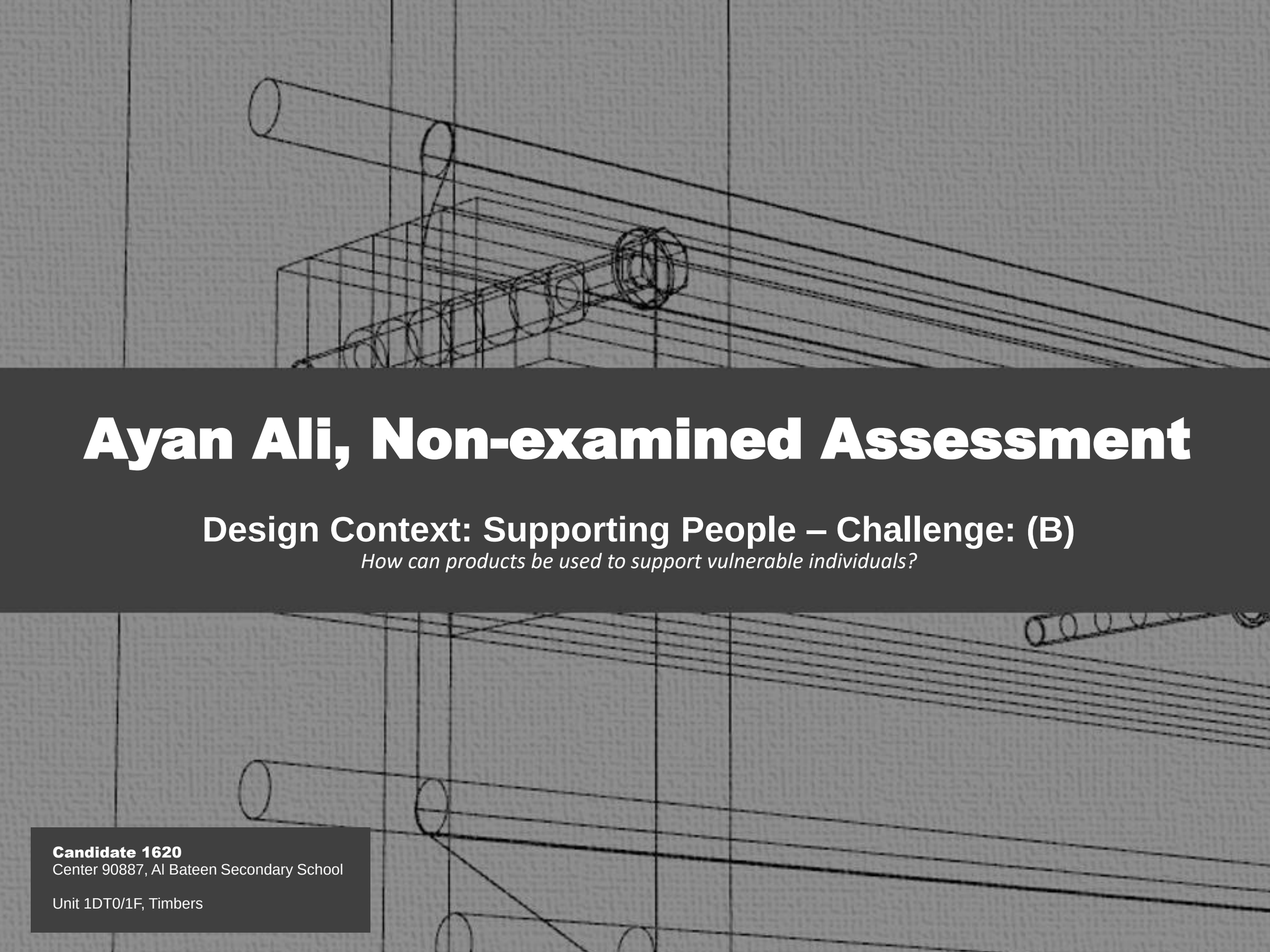
Ayan Ali, Non-examined Assessment

Design Context: Supporting People – Challenge: (B)

How can products be used to support vulnerable individuals?



Candidate 1620
Center 90887, Al Bateen Secondary School

Unit 1DT0/1F, Timbers

Table of Contents

**The page number of a certain page is given in the heading of said page.*

(03) Initial analysis of the context

Introduction:
In this section I will be investigating the following phrases: supporting people and vulnerable people, I will also briefly investigate existing products which help support vulnerable people. Finally, I will also begin to identify possible customers for such products, and how they may function when the end-user uses them.

Figure 1.1 - A typical sports prosthetic

Figure 1.2 - A Life straw used to filter dirty water

Figure 1.3 - An IKEA portable refugee shelter

Figure 1.4 - A typical mouth operated computer mouse

Further examples of products that support and help vulnerable people:

Figure 1.3 shows a flat-pack IKEA refugee center, this refugee center can easily be assembled and is somewhat permanent. This is good as refugee shelters need to be hard-wearing yet portable and easy to assemble. Also, using a tent-type structure is not useful as it is easy to cut open, and can easily be destroyed by bad weather or by war. The refugee shelters can also be retrofitted for kitchens, medical facilities, schools, etc. They can also be used in bad weather such as tsunamis or earthquakes or due to rising sea levels. One issue with this design is that since it is made from plastic sheets rived together with metal rivets it may not last long in areas with acidic gases that cause acid rain, or in areas of extreme heat / cold. Another issue is that the plastic may not be biodegradable thus polluting the environment. A possible solution would be to use a biodegradable plastic and to use a more hard-wearing composite.

Figure 1.4 shows a typical mouth operated mouse, this is where the user uses their mouth and teeth to pull the joystick in different directions to move the mouse on the screen. The clear plastic tube is connected to the joystick which allows the user to create negative and positive pressure by blowing or sucking, this corresponds to a left click or a right click on the computer. This helps support the vulnerable people who have certain diseases/ genetic conditions as it allows them to do certain tasks such as playing computer games, surfing the web, productivity, research, etc. This also allows them to get jobs that require operating computers daily and allowing themselves to become more independent. One issue with this design is that if the boom arm is not secured to the desk properly or if the boom arm does not have a sufficient grip / hold on the table it can result in mouse being difficult to control or can also result inaccuracies thus resulting in user frustration.

What is meant by the phrase 'supporting people'?:
Supporting people is the broad term used to describe anyone or anything that helps a person restore another person's freedom of choice to its former ability. An example would be a leg prosthetic used to help a person with a missing leg play sports or to be able to ride a bike. This product also reduces their susceptibility of being taken advantage of and increases their freedom to move around freely.

Figure 1.1 shows a typical prosthetic leg. This allows the user complete freedom to perform everyday task such as sports and allows them the same freedom as a person with no missing legs. One issue with this is that when walking normally the joints in your leg may start to hurt due the force being absorbed by less bones thus making it painful. A solution may be to introduce a more streamlined design for better force absorbency or to use more advanced composite materials so that forces is evenly distributed on the leg mold.

Figure 1.2 shows a device that is used like a straw, this device filters out dirty water to leave clean water. This helps those who are vulnerable to dirty water such as refugees, people in poverty, etc. One issue with this is that it is unable to filter out chemicals and heavy metals in the water, thus making it unsafe in regions where companies dump chemicals / metals into water sources. A solution for this may be to introduce a larger module that is powered through a hand pump that is able to filter out these hazards.

What is meant by the phrase 'vulnerable person'?:
A vulnerable person is the broad term used to describe anyone who is susceptible to or at the mercy of a certain chronic disease, a condition, situation, a mental disc order, etc. This vulnerability can cause the person to be unable to become independent, thus reducing their freedom. Examples of vulnerable people may include someone with a disability such as a missing leg, this can cause the person to be unable to play sport and be unable to go to certain places thus resulting in their loss of freedom of choice on what they want to do.

Identifying further examples of vulnerable people:
A vulnerable person is not confined to a single demographic, or ethnic minority, but rather can be applied to a wide range of people. Some example are outlined below:

(1) A person living in a region of water scarcity, or in a regions of dirty water is vulnerable because they may not be able to grow crops are may not have enough water for themselves or for cattle
(2) A person living in highly populated regions such as the city of Shanghai, China is vulnerable because of the large amounts of hazardous materials in the air
(3) A person living in a rural area may be vulnerable to adverse weather, as they may depend on crops, that if destroyed would mean they have no source of food. They also may be vulnerable as they may not be near any healthcare services.
(4) A person with special needs may be vulnerable as they may not be able to carry out day-to-day tasks effectively

Conclusion:
After conducting this research, I have identified some vulnerable people, their conditions, existing products and potential problems and solutions for these products. Additionally, I have better understanding of the design context, which in turn helps me gain a better understanding of my target market and helps me work towards formulating a rough design brief.

Moving forward:
Next, I plan to build upon the above list and identify a large range of vulnerable people, this in turn will help me narrow down my target customers so that I am able to figure out my target market and formulate a final design brief.

(04) Vulnerable People Categorical Analysis

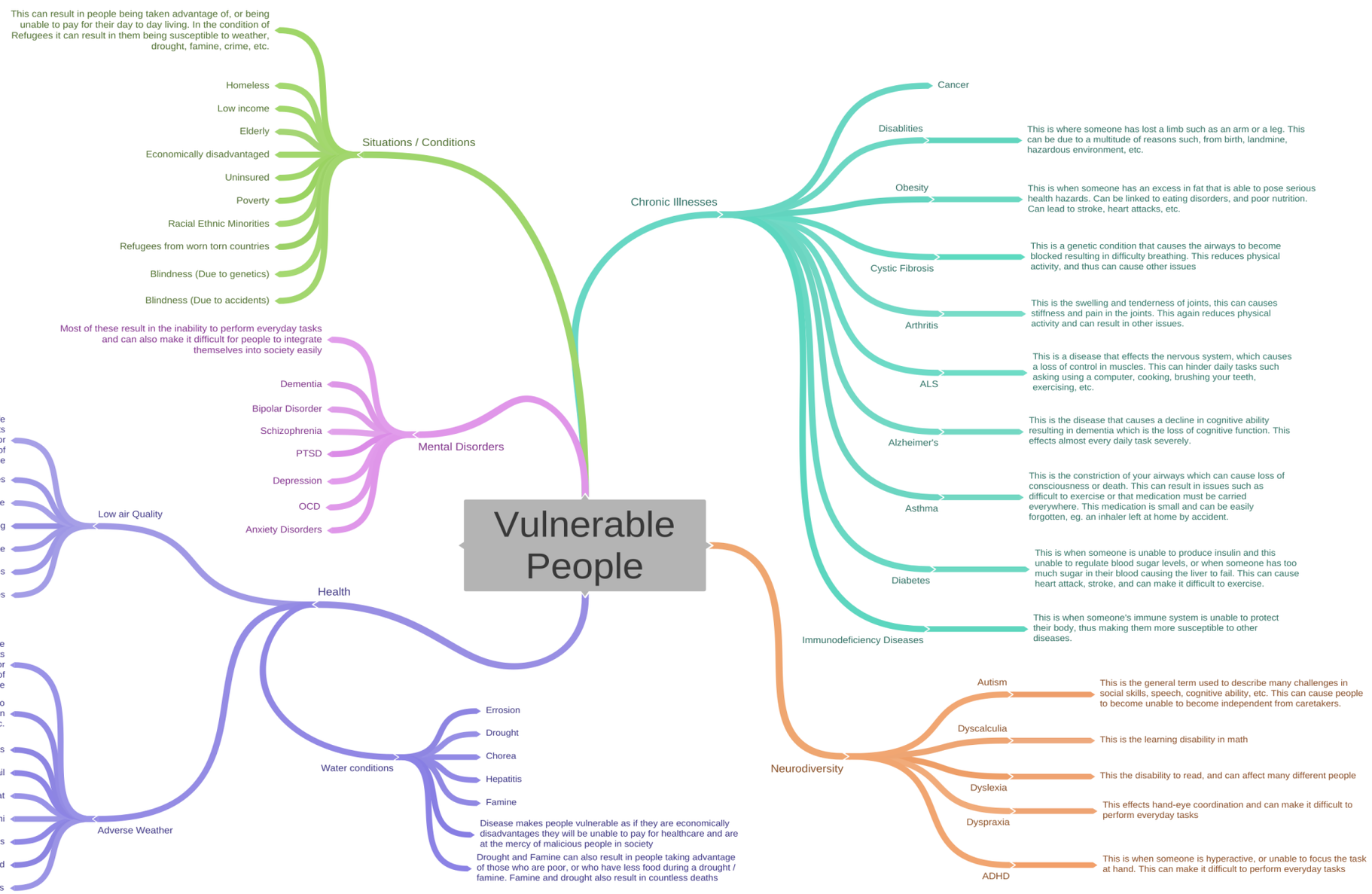
Introduction:
In this section of the investigation, I plan to identify a larger range of vulnerable people, this in turn will help me gain a better and wider understanding of categories of people that are vulnerable. This in turn would help me identify design possibilities, and ultimately help me formulate my design brief.

What is meant by the phrase 'neurodiversity'?
It is the term used to refer to the variation in the human brain regarding sociability, learning, attention, mood, cognitive ability, etc. In other words, it refers to how different people have different capabilities, and refers to how some people have certain conditions that effect their learning, attention, mood, cognitive ability etc.

For example, someone with ADHD is unable to focus on the task at hand and is hyperactive. This makes it difficult for them to learn new things, and results in mood swings.

Conclusion:
After completing this page, I have identified a large variety of vulnerable people and their conditions, this in turn helps my find possible target customers for the design context. Furthermore, I am starting to formulate possible products I could be producing for these target customers. I am leaning towards designing for customers who are vulnerable because of; Adverse Weather; Neurodiversity; conditions related to Aging such as vision dimming, low grip / strength, joint pain, etc.; refugees; and those in poverty.

Moving forward:
Next, I plan to thoroughly investigate existing products that are used to help support the vulnerable people categories that I have identified I want to design for. This, thus, will help me narrow down my target market and will also help formulate my final design brief.



(05) Preliminary Existing Products Investigation

Introduction:
In this section of the investigate phase I will analyze existing products used to help support the vulnerable people categories I have previously identified. I plan to look at their exact target market, potential problems with said products, and possible solutions to said problems. This in turn will help me narrow down the target market I want to design for, which in turn will allow me to formulate my design brief.

Figure 2.1 - A worker on the side of a slope laying a roll of jute fiber

Figure 2.4 - A jar opener to provide a mechanical advantage over the lid

Figure 2.2 - A quick-install concrete tent

Figure 2.3 - Interconnectable light panels used in sensory rooms

Figure 2.6 - A pack of "plug tugs"

Jute fiber – Water Scarcity, and subsistence farmers:
Figure 2.1 shows a roll of jute fiber, it is an agro-textile used to prevent erosion to the soil by holding the soil particles together, almost like plants' roots would do. They are usually placed underneath a topsoil layer or are layered between thin layers of soil to ensure that the soil does not move. This is very useful when civil engineering projects like canals, parks, etc. One issue with using jute fiber is that it may have been treated with chemicals and if these chemicals are not properly removed it could result in chemicals seeping into water sources, harming people and wildlife. A solution for this would be to properly clean / wash the fiber before use, and to use less harmful chemicals during processing. Indirect Target customers for this could be the people that are vulnerable to drought and erosion, such as farmer's who's only income is their crops, so if the crops were to fail it could result in famine, and poverty for their family. They also prevent dangerous landslides, and water droughts in areas of water scarcity.

Mechanical Advantage Jar opener – The Elderly, muscle deficiencies, and low grip disorders:
The jar opener shown in figure 2.4 is used to provide a mechanical advantage of the lid of the jar, so that less force is required to open the jar, thus making it easier to open the jar. This could be especially useful for the elderly, or people with muscles disorders which means they cannot exert the same amount of force as compared to an average person, or a wheel-chair bound person as they won't be able to get good leverage. The jar opener itself is simple, and minimalistic meaning that it is very cheap, meaning that it is very efficient to make as there is no wastage in the manufacturing process. The plastic itself appears to be rubbery, meaning that it is most likely non-biodegradable, this can be a problem at the end of the lifetime of the jar opener as it is not a common-place plastic so is unable to be recycled, and is non-biodegradable thus polluting the environment at the end of the lifecycle. A solution to this would be to make the opener out of a more common-place plastic, or to make it biodegradable. This would also make it more-environmentally friendly and will also help increase appeal to a larger range of customers.

'Plug Tugs' – The Elderly, muscle deficiencies, low grip disorders, dimmed Eyesight:
Figure 2.6 shows a pack of "plug tugs", these are plastic strips that have holes in them so that it can be placed onto wall plugs, this will leave two ends of the plastic strip which has have glue on them so that they can form a loop. This allows the elderly / those with muscles disabilities to pull the plug out of the wall socket with minimal force. One issue with this product is that the plastic is translucent meaning it will be very difficult to see in low light conditions, or those people with partial blindness, solution for this would be to paint the plastic with glow-in-the dark pigments, or to paint them in a bright color. Perhaps it may be possible to have different colored tugs in a pack so that a customer is able to see what plug is connected to what device at a glance.

LED Light Panels – Neurodiverse people, and mental disorders
Figure 2.3 shows interconnectable light panels that can communicate with each other to produce different colors and patterns of light. They work like a "hive mind" and can display complex patterns without having any main computer controller. They connect like "Legos" to form a large panel of shape or size. This is useful for children with conditions like ADHD, autism, or dyspraxia where they need to go to sensory rooms to help ease their symptoms. The panels are easy to install reducing the costs of making sensory rooms in school and other public spaces, this can make neurodiversity cures more accessible to the public and to those in developing countries. An issue with these panels is that if one of the panel's microprocessor fails it will result in the other adjacent panel failing, this will require repair which might be difficult in developing countries. A solution for those would be to but a microprocessor in each of the panels so that there is redundancy, or to use simpler and standardized components so that it can easily be repaired.

Quick-Install Concrete Tent – Poverty, Adverse weather, and Refugees
Figure 2.2 shows a typical quick-install concrete tent. The tent consists of two layers of a high-strength nylon lattice, which has quick-dry concrete sandwiched between. It is almost like plaster cloth. To assemble the tent, you would first have to lay it flat on the ground after taking it out from its compact shipping box, then you would have to use an air compressor to inflate the tent, and then you would need to spray water over the tent to activate the concrete. You would then allow the concrete to dry, so that the result is a solid concrete tent. This can be a life-saving measure after a conflict in refugee camps and can also be a life saver during a natural disaster as it could provide a semi-permanent clinic building, or a shelter. This can save lives and can also save money as it is cheap and easy to deploy. One issue with this is that it might be difficult to tear down after usage, as it is made of concrete. It is also considered unsightly so it may not be viable for very long periods of time.

(06) Preliminary Existing Products Investigation (Continued)

Fiber Optic 'Waterfall' – Neurodiversity and mental disorders
Figure 3.2 shows two "waterfalls" of fiber optic cables, it has a control box on the top where the fiber optical cables go into. Inside this control box is secure mounting for the fiber optical cables so that children are unable to pull down the cables, a LED controller for different effects and light settings, and a strip of LEDs which are individually connected to each of the fiber optic cables. This is useful for children with conditions like ADHD, autism, or dyspraxia where they need to go to sensory rooms to help ease their symptoms. A possible problem with these waterfalls is that may contain fiber optic cables made form glass, this can be a problem as the fiber optics will not be able to flex well and can break, this can cause safety issues with young children as they may get injured. A solution to this would be to use plastic fiber optics as they have a high flexibility, are can handle high stresses without damage, this in turn will increase the safety and lifetime factors this increasing the appeal of the product.

Stair Support - The Elderly, muscle deficiencies, low grip disorders, and balance problems:
Figure 3.1 shows a sliding support bar that can be slid up the stairs with the person so that it is able to provide support to people the elderly / people with stability / muscle deficiencies. The slider has a lock on it so that if your hands are squeezing the bar the slider will unlock and if they aren't they will stay locked, this is to prevent the slider from sliding back when a person is climbing up the stairs. It also appears to have a hinge so that it can pushed aside when not needed, this in turn will keep the staircase open so that walking up and down normally is un-hindered. One problem with this design would be the high setup costs, this is because a new guide rail needs to be installed, and since different houses / living spaces have different layouts, you need a system that is flexible which can increase costs as it would be need to be custom built, at a one-off scale. Perhaps having a system that can latch onto existing staircase guide rails would be a better idea as setup costs would be much lower, this would be especially good for the elderly as they have low pension / aid incomes, and this can be very costly for them. Another problem is that during the night or in areas of low light conditions it can be a big problem for the elderly, or vision impaired to climb down the stairs, in this case maybe a combination of installing a light system, reflectors, and glow-in-the-dark pigments into the plastic assembly may increase the customer reach, safety levels, and reliability

Disability Cutting Board - The Elderly, muscle deficiencies, and low grip disorders:
Figure 3.3 show a disability cutting board, this cutting board is used to help those with low grip / muscle disorders / the elderly, etc. The cutting board contains a slider in which food items can be places so that they can be easily cut. A possible problem with the board are the share nails used to grip more irregularly shaped items, this can be a problem as it can be very easy to cut yourself on them, perhaps making the blunter, or removing them pin place for a large slide would be better. Also, enlarging board and increasing the number of suction feet will increase its usability. Another possible upgrade would be making the slider handle high visibility or bigger so that people with impaired vision will have no trouble seeing it. Perhaps also including a ledge in a corner so that bread can be placed against it for easy spreading may also be beneficial for ease of use.

Aluminum Briefcase Ramp – The elderly, wheelchair-ridden, Muscle Disorders, Disabled:
Figure 3.4 shows an aluminum ramp that can be folded in a briefcase. This increases the reach of those in mobility scooters / wheelchairs and allows them to reach area that otherwise won't be reachable without the ramp. The ramp is also corrugated to decreases its flexibility so that it doesn't buckle under the strain of the load. A problem identified with the ramp in its customer reviews is that it rattles when being carried around, this is because of the aluminum ramp edges hitting each other due to the slight flexibility. A potential solution to this would be to apply "plastic dip" on the ramp, this would improve the grip of the wheelchair tires, but a problem would be that the plastic may start to yellow under the sun or may deteriorate throughout the usage of the ramp. Perhaps adding rubber sidings to the edges of the ramps so that the sound is muffled.

Easy Pour Kettle – The elderly, muscle deficiencies, Low grip disorders, and dimmed vision:
Figure 3.5 shows an easy pour kettle, it is designed for those who are unable to hold large weights or have grip deficiencies. The kettle pivots on a pivot placed in the center of the kettle body, when pivoted, hot water can fall exactly into a cup easily. It has an ergonomic design to help aid the user and to make it more pleasant to hold. A potential problem with this kettle is that there is no extra slack in wire, this can be a problem if the wire is overstretched as the kettle may not be able to pivot, a potential solution would be to add an extra section of wire connected to the black base which is enough to allow the kettle to pivot freely.. Another problem with this design is that the cup may be too far from the kettle spout which may cause hot water to splash, a potential problem to this would be to add an adjustable holder to hold the cup, or to reduce the height of the stand.

Conclusion:
After completing this section of the investigation phase I have identified two major target markets that I would like to design for: The elderly, and those vulnerable to the effects of climate change such as adverse weather. I have also identified existing products, how they can be improved, and how they work. This in turn will aid me when finalizing my design brief. Also, after completing this Preliminary product investigation I have identified some products that I am able to further analyze in the Refined product investigation.

Moving Forward:
Next, I plan to conduct two interviews, one on a customer who suffers from problems related to the elderly, and the other who suffers due to the impact of climate change. This in turn will help me understand the needs and wants of these target markets, which in turn will help me ultimately decide which one of the two markets I want to design for.


Figure 3.3 - A disability cutting board


Figure 3.2 - A fiber optic "waterfall" used in sensory rooms


Figure 3.4 - A aluminum ramp that can be folded


Figure 3.1 - A sliding guide, used to provide support


Figure 3.5 - A easy-pour kettle

(07) Client Interview #1

Introduction:
After researching my contextual question, identifying possible customer markets, and analyzing existing products. I have narrowed down the target markets I want to design for into two distinct categories, the elderly, and those effected by climate change. Here I will interview a person effected by extreme flooding to help me make an ultimate decision on which target market I want to design for.

Client Profile:
Name- Abdirahim Omar Elimn
Age- 39
Sex- Male
Occupation- Subsistence Farming
Hobbies- Exploring new farming methods, and trading goods locally

Client Summary:
Mr. Elimn is aged 39 and is a subsistence farmer, he enjoys exploring new farming methods, and trading goods in nearby cities. Lately he has been suffering because of climate change on his farm, particularly due to the extreme droughts and extreme flooding. He has been looking for solutions to these problems in the form of digging a well or making a floating raft to support his crops when a flood passes through. He is looking for products to help solve these problems as he unable to do it himself as he does not have enough money and cannot put his family at risk.

What is a need and what is a want?:
A need is something basic that is needed for the product to function properly and attract customers. While a want is something that would be preferred and is not required for customers to be attracted to the product / for the product to function but rather is there to help attract a wider range of customers. This is because it may appeal to more people.

Conclusion:
After completing this interview, I have a better understanding of this target market's needs, wants, and what type of product they are looking for and why.

Moving Forward:
Next, I plan to conduct an interview with the elderly to figure out their needs, wants, and what types of products they are looking for and why.

Tell us a bit about yourself:
Mr. Elimn says he is aged 39 and works on his small piece of land where he farms with his wife and two sons. He says he lives a simple life; he farms only to feed his family and to make some extra money to send his children to a public school nearby, and to also buy goods that may be needed in the household. He says that the land has been passed down from his father and he has worked on said land for all his life, he considers the land his "lifeblood". He spends his extra money on extra goods and trades them in nearby cities for a small profit, he particularly likes "finding new methods to improve my crop yield and crop quality".

What situation have you been suffering from, and for how long?:
Mr. Elimn says that there has been extreme weather in the area he farms. He says that "we sometimes get too little rain, and once we wish for more rain, we get so much that it floods our lands". He says that there have never been droughts or extreme weather conditions when he was younger when he worked with his father, he has a basic idea on why suddenly the conditions are worsening. He blames this worsening condition on "climate change", he came about this knowledge when he was in a nearby city reading newspapers while trading his goods for profit. The client says he has been lucky, but other farmers nearby have not been so lucky and have had their crops destroyed by extreme drought or by flooding. He says he is fearful for the moment his luck runs out, as he will be unable to provide food and wealth for his family.

How have you found a workaround for this situation?:
The client has already started to move his fields into a higher elevation, but this is not possible for all his crops as his land is flat and is relatively low compared to the surrounding areas making him prone to flooding. He has also considered creating a type of raft, where if heavy rains come the crops will float above the flood water and will sink back down when the water has passed. For the drought conditions he has also considered employing laborer's to manually dig a well so that he is able to tap into the ground water table. He says that digging a well will be very costly and is a big risk for his family as he may not find any water. He also says that making rafts will be costly for him as he does not have the expertise and is unsure if the idea will even work.

If a product was designed for your situation, what would you require from said product?:
Mr. Elimn said that product should be long-lasting so that cost are kept down over a long period of time. He said that he would rather invest a large sum of money in the beginning and not have to worry about repairs or it breaking for a very long time. He would also prefer it came in a kit so that he himself is able to source the bamboo or wood, and all the other Metallic or plastic parts came in the kit. He also says that the product should not be electrically powered as he only has a pair of solar panels that run a fridge and 2 lights in his home, anything else added onto the grid would cause a load on the circuit.

Needs	Wants
Functionality- A product that will either help support him in drought or in floods.	Education- Perhaps including a book / booklet on how to operate the device properly, and why climate change is happening may be beneficial
Independent- The product should only be operated with one person, so that they are able to remain independent.	Power- The product would preferably not be electrically powered, or at least not require electricity to complete its main function
Cost- The cost of the product should be relatively low as Mr. Elimn is in the working class	Repairs- The product must be simple / have standardized parts to aid easy repairs in case they are needed.
Sustainability- The product should contain materials that are sustainably sourced and can easily be recycled	Materials- The product should preferably come in a kit so to reduce costs, and to make sure that the wood is sustainably sourced.

(08) Client Interview #2

Introduction:
After researching my contextual question, identifying possible customer markets, and analyzing existing products. I have narrowed down the target markets I want to design for into two distinct categories, the elderly, and those effected by climate change. Here I will interview an elderly person to help me make an ultimate decision on which target market I want to design for.

Client Profile:
Name- Ramzan Malik
Age- 86
Sex- Male
Occupation- Retired, previously working in Pakistan Postal Service
Hobbies- Reading, exercising, and spending time with his family

Client Summary:
Mr. Malik is aged 86 and is well into his retirement. His previous job before Retirement was in the Pakistan Postal Service, where he worked as a postman. He has problems in his knees due to a childhood incident where he damaged them severely. When he was younger this knee problem was not a big deal as it had healed quickly, but towards his 80s he has started to struggle due to the degradation of the joints throughout his body. He enjoys reading, spending time with his family, and exercising as regularly as his condition allows. In his home in Karachi, Pakistan, he struggles going up and down the staircase due to his damaged knees, he has tried many methods of reducing the force on his joints to no avail, so he tries to stay on the ground floor as much as possible, but this is sometimes not possible as he may need to go upstairs for different tasks. He doesn't want help from others as he wants to be self-sufficient and independent. He has been looking for a simple system that will allow him to easily go up and down the staircase, but it has been difficult to find one that suits his needs. He would also prefer if said system was not electrically powered and was there to only help guide him up the stairs, this is because there are regular power outages in the district he lives in. Additionally, Mr. Malik has identified other tasks that are starting to become more difficult to him, he has identified preparing food, and transporting heavy objects. He has also started searching for solution to these tasks

Tell us a bit about yourself:
Mr. Malik says he is aged 86 and is retired. He also says that he used to work in the Pakistan Postal Service as a postman, but in his later years he worked as a manager for the regional post office near his him in Karachi, Pakistan. He also says that he "enjoys reading, exercising as regularly as his condition allows, and most importantly spending time with his family". He mostly likes reading historical and scientific texts.

What condition have you been suffering from, and for how long?:
Mr. Malik has said that he has been suffering "joint pain especially when putting heavy loads onto his joints or overextending them". He says he must be very careful when climbing stairs as he has lost certain small muscles in his knees which help prevent the knee from bending in the wrong direction. He says that these damaged muscles are due to a childhood accident but is unable to recall as he "has long forgotten the details" as he was very young at the time and had healed quickly so it was not a big deal for him. He has also said during his early life this joint pain has not been a large problem, but towards his later years, specifically between "78 to the present" he has been having some troubles getting up the stairs.

How have you found a workaround for this condition?:
The client has said that "he tries to stay on the ground floor of his home" in Karachi, Pakistan as much as possible. He says this is sometimes a problem "as he may need to check the boiler and auxiliary water storage from time to time". He is unable to ask his sons to do this for him as they work long hours and sometimes work long night shifts in a petroleum refinery. But either way he doesn't ask them to do so as he wants to remain "independent and self-sufficient" from others. Mr. Malik also says that he has tried to find other methods of reducing the stresses on his knees such as using a makeshift Zimmer frame that one of his sons made for him or using crutches to climb the stairs to no avail.

If a product was designed for your condition, what would you require from said product?:
Mr. Malik said he would like 3 main points addressed with such a product. Firstly, he would like that the product is not electrically powered as he said, "the district that we live in has regular power outages so I could be limited to the times I want to go upstairs". Next, he said that he wants the product to contain "sustainability sourced materials, and materials that are easy and simple to recycle" he says this as he has seen too often that products are designed to have pre-determined obsolescence or are designed to be anti-recyclable. He says he considers this the most and would place this above all else. Lastly, he has also said that he wants the product to be self-operated so that he is able to go up and down the stairs whenever he wants, thus maintaining his independence.

Do you have any other problems with day-to-day tasks?:
When asked this question the client said that there were no other problems with executing day-to-day tasks, but later he had said that he is "starting to have difficulties preparing food and carrying heavy objects around such as delivery packages and perishable products such as fruits and vegetables from the local bazar". He says he has started to consider thinking for addressing these needs soon, as they may worsen.

Conclusion:
After completing this interview, I have a better understanding of this target market's needs, wants, and what type of product they are looking for and why.

Moving Forward:
Next, I plan to compare the findings from these two interviews and from my previous investigation to finalize what target market I want to design for.

Needs	Wants
Functionality- A product that will either, support him up the stairs, help him prepare food, or carry heavy objects	Looks- Preferably the product should be elegant-looking so that no moving parts can be seen
Independent- The product should only be operated with one person, so that they are able to remain independent.	Power- The product would preferably not be electrically powered, or at least not require electricity to complete its main function
Cost- The cost of the product should be relatively low as Mr. Malik is retired	Repairs- The product must be simple / have standardized parts to aid easy repairs
Sustainability- The product should contain materials that are sustainably sourced and can easily be recycled	

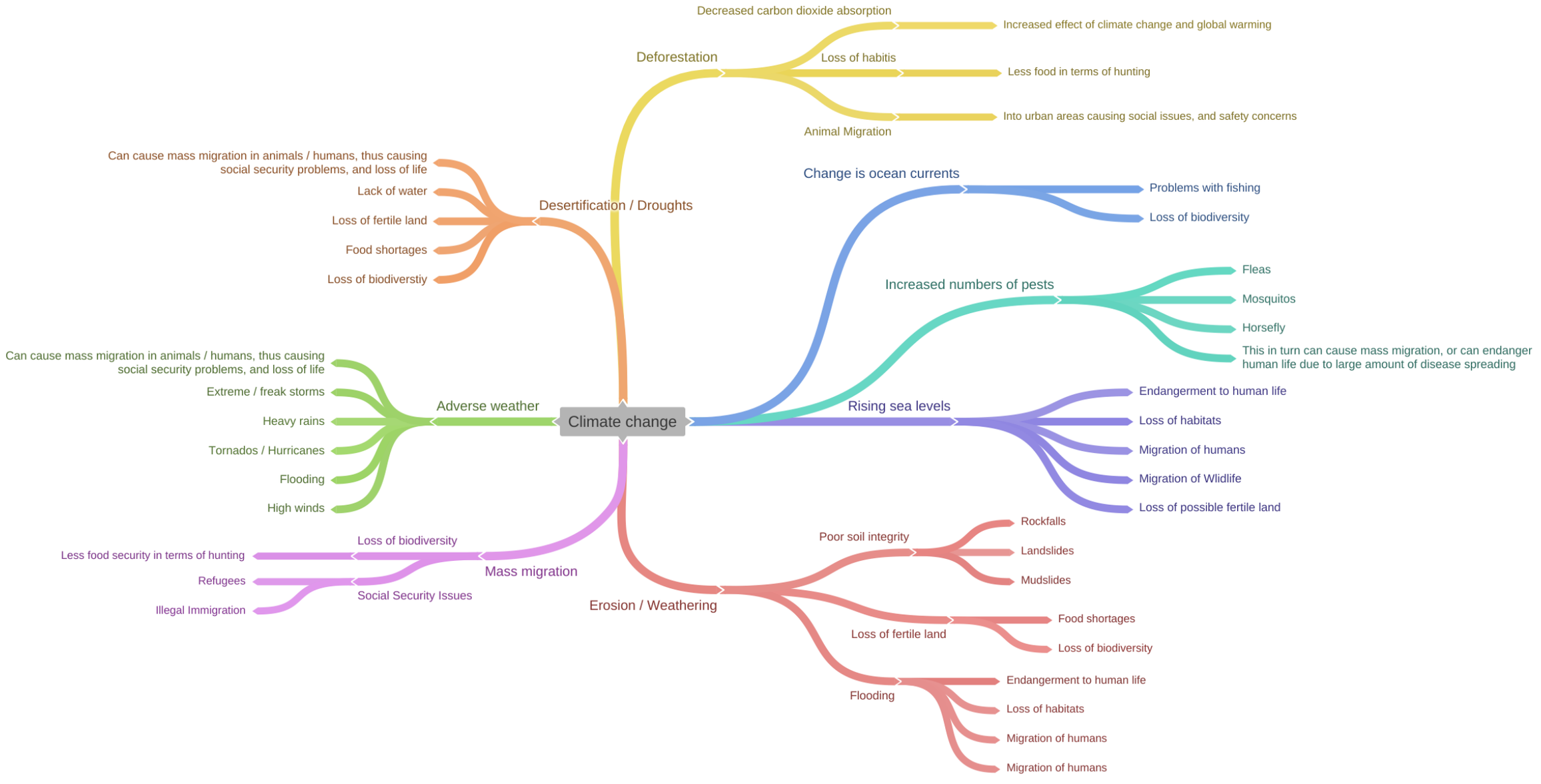
(09) Problems Associated with Climate Change

Design Decision:
Overall, I have decided to move forward with a product that will be able to support those vulnerable due to climate change from the two major markets I previously identified and interviewed, this is because the effects of rampant climate change is an emerging problem that will start to become more widespread in the coming years and so addressing these problems and creating solutions for said problems early most likely will be more beneficial.

Introduction:
In this section of the investigation, I plan to identify a range of problems associated with climate change, thus allowing me to gain a better and wider understanding of the possible products I can analyze on the next page. This in turn will help me figure out the final target market I will be designing for, which will help me formulate my design brief.

Conclusion:
After completing this page, I have identified a large range of problems associated with climate change and how climate change is able to effect people. This in turn will help me identify what existing products I can analyze which in turn will help me figure out what designs are successful and what are not so successful. This, thus, will help me prepare my final design brief and will also help me move towards designing a product to fulfill said design brief.

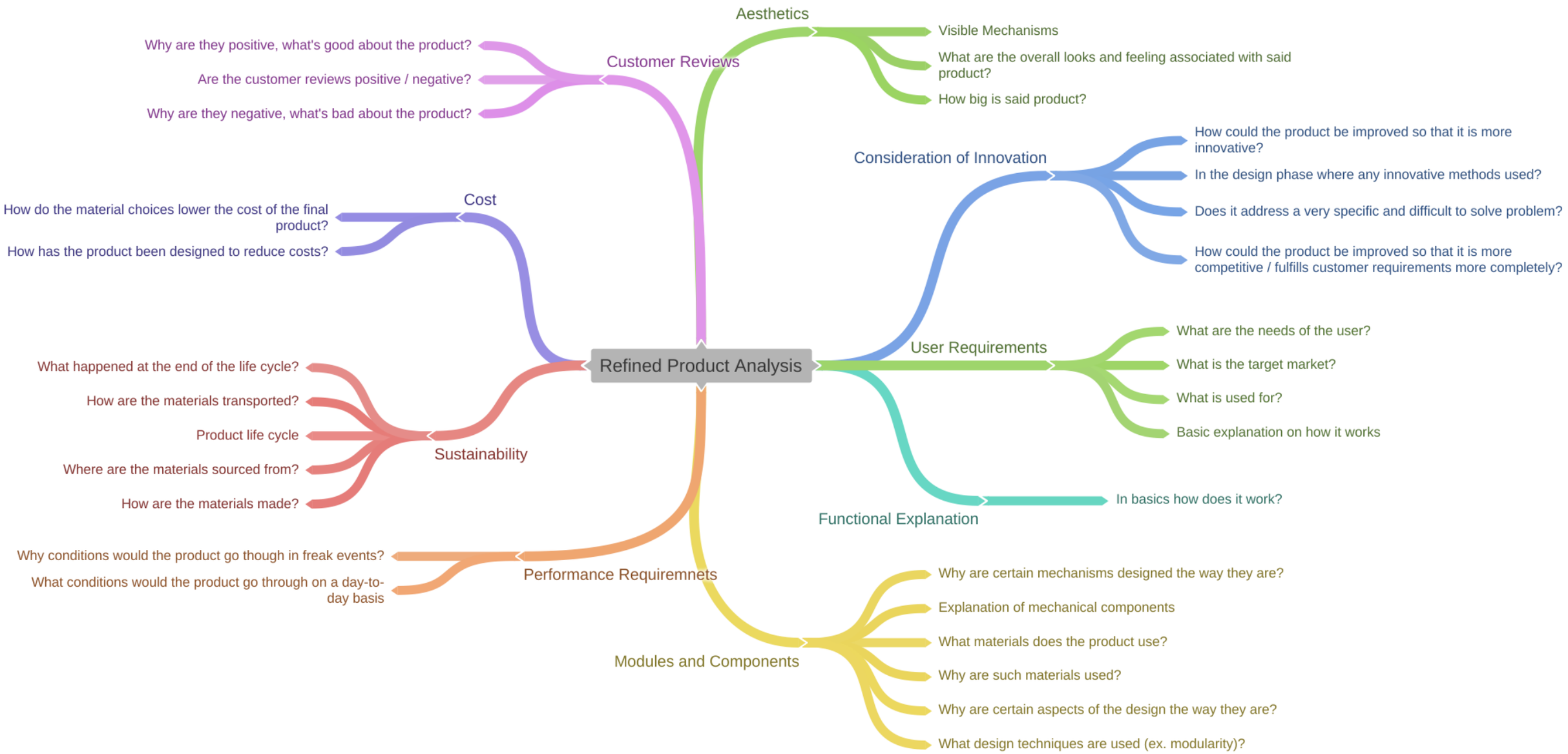
Moving forward:
Next, I plan to investigate 3 existing products, I will talk about Aesthetics, Sustainability, Consideration of Innovation, Materials and Components, Performance Requirements, User Requirements, Customer Reviews, Cost, and a Functional Explanation. I will then summarize this into three parts, inspiration I will take from the product, the pros of the product, and the cons of the product.



(10) Refined Product Analysis Questions

Introduction:
In this section I plan to analyze a range of products that are used to help those who are vulnerable because of the effects of climate change. I plan to analyze based on the following criteria, Aesthetics, Sustainability, Consideration of Innovation, Materials and components, Performance Requirements, User Requirements, and Customer Reviews.

Conclusion:
After completing this page, I have a better understating of what I should be asking in the next three pages in my refined product analysis. This in turn will help me ask the necessary questions which in turn will help me formulate my design brief.



(11) Refined Product Analysis

Mountain Fog / Cloud catcher:

Figure 4.1

Figure 4.2

Figure 4.3

User Requirements:
This product is useful as at this altitude the mountains are not tall enough for ice, and too high for rivers so it is very dry up here, this can be a very big problem as there will not be enough water to drink, feed animals, and to water crops thus making it extremely difficult to survive, as the people will be vulnerable to starvation, thirst, and social security issues if they must migrate into areas of higher water content.

Aesthetics:
For the target audience, and the usage of the product the appearance of the product does not matter as much compared to its main functionality which is to collect water in regions of drought, or in regions of water scarcity. Overall, the product has an industrial look with aluminum poles and black water catching nets called "cloudfishers".

Materials and Components:
The design is composed of 5 modules, with each section being supported by two aluminum poles (A) that are about 4.5m long. The design is also built with modularity in mind meaning the system can be extended so that the volume of water extracted can increase, this is especially useful for larger villages where 5 modules may not be enough. The poles are set into concrete blocks (B) that are roughly 0.5m x 0.5m x 0.5m. Concrete is used as it is heavy thus creating a strong base for the system. The poles have hinges (C) on the bottom to ease installing and repair, or to make sure that in high winds the device can be safely packed without it getting damaged. The poles are of the same length so that the product is standardized and thus easier to produce at a lower cost. But since the product needs to be installed anywhere possible to increase the water yield the cross beams (D) have designed in such a way that they are able to installed at any position along the pole so that the net stays square even if the poles are at different elevations. The crossbeams are roughly 1m in length. Aluminum has been used for the poles as, it is first easier to carry up the mountain as it is lighter, second as it is cheaper than other metals of similar properties and is also non-ferrous meaning it will not rust in the harsh conditions of high winds and extreme humidity. The nets (E) ("cloudfishers") are made of a specially designed lattice structure which contains hairs between the two outside layers, there are thousands of these tiny fabric hairs between the two sides of the fabric. The cloudfisher nets have been attached to the aluminum poles and crossbeams using aluminum cable ties (F), they have been installed with an extremely high tension so that the nets do not flex in the wind and are able to catch as much water as possible. There are also aluminum cables (G) that connect to the poles and to long barbed steel pegs that are hammered into the ground. The cables provide extra support and as the make a triangle shape for the best possible stability in the high winds in the mountains. Towards the bottom of the product there are white plastic bottles (H) for holding the water collected in the trays above, one problem with this would be that they would fill up quickly and would also be a pain to empty into a larger water storage tank, perhaps installing a large 5000L plastic water tank lower in elevation compared to the product may be more convenient for the village.

Performance Requirements:
The product will be subjected to large amounts of water and wind, it will also be subjected to high hand low temperatures throughout the day and night. This means the product needs to be able to withstand the high stresses from the wind and water and should also not rust due to the water as it would reduce the stability of the system. The product should also be able to handle the expanding and shrinking of the metal throughout the day so that it does not fall apart.

Sustainability:
Firstly, since aluminum has been used the product is much more sustainable as aluminum is produced mainly through recycling old aluminum, this is because mining the ore of aluminum and then using electrolysis to extract it makes it extremely expensive for companies to produce as it requires a lot of energy, this in turn results in many companies recycling their aluminum for making new products. Also, since the product is built to be long lasting the product is relatively sustainable as it does not need to be repaired often. It also contains components that are not that complex meaning once the lifetime of said product has finished the product can be easily recycled. The nets are also not made of plastic but rather a synthetic cloth that is hard-wearing and that is also easy to recycle / produce. A problem with this product is that the carbon emissions of shipping aluminum from countries such as China or India to the Africa (specifically Morocco) and shipping these specialized nets from Germany will be very high.

Cost:
The product seems to have been designed to keep costs down, this is because it uses aluminum materials, and does not use any specialized or rare components, other than the net, but this is also able to substituted for a "DIY" type of net that is able to be made from fishing nets of varying sizes. The product has also been created with modularity and standardization in mind, this in turn reduces the amount of differently objects and items needed to successfully deploy said product thus making it cheaper.

Customer Reviews:
No customer reviews as the product is new and is targeted at those in developing regions. The product has also not been mass-produced and is also still under research. Although something worth to note is that this project has won a UN climate change award. But I believe this product will sell well to organizations like the UN and the Redcross, as it solves a large problem that they are trying to fix.

Consideration of Innovation:
The product is quite innovative, it firstly does this by addressing a problem which has been a very large problem in regions of water scarcity or in areas with extreme droughts. Also, the cloudfisher net has been specially designed in such a way to aid catching the largest amount of water, the nets have been designed through computer simulations, and have gone through large numbers of prototypes to reach the final design we see now. Perhaps using wind sensors and motors to automatically deploy and retract the modules may be beneficial as it may decrease the risk of it being destroyed due to extremely high winds.

Functional Explanation:
The products works by catching the large amounts of water in clouds and fog, it does this by literally blocking the path of water flying and catching it on the nets, the water is then carried by gravity to the bottom into a collection pipe where it is piped into tanks.

(12) Refined Product Analysis (Continued)

Makeshift Floating Garden:

User Requirements:
A floating garden like this is used to elevate crops from the ground, this is done so to protect the crops from heavy rains due to global warming or due to wet seasons. If the crops were placed on the ground the large amounts of water would kill the crops, this in turn can be a huge problem for families in developing countries where they depend on crops for a food and wealth source. This could also be a solution for countries that are starting to face the rising sea level due to climate change, these floating gardens can act as a temporary solution until people are moved to areas with higher elevation, or until the climate change is curbed through emerging technologies.

Figure 5.1

Aesthetics:
For the target audience, and the usage of the product the appearance of the product does not matter as much compared to its main functionality which is to prevent crops from being damaged by allowing them to float above the flood water. But perhaps including a more ergonomically good mounting system would be beneficial to allow the floating device to be moved around easily, or to allow the device to be disassembled by using design for disassembly.

Materials and Components:
The bottom of the floating garden contains plastic floats (A) that allow the garden to float above the water, and also contains a bamboo structure (B). Bamboo has been used as it is cheap, easy to source, and is buoyant.

Performance Requirements:
The garden will be exposed to large amounts of rain, wind, cold, heat and generally a large range of climates as it will be active throughout the year in different seasons. This means that it will need to be hardwearing, and the joints and connections will need to be easy to repair or will need to hold for a long time.

Cost:
Costs are relatively low as it appears locally sourced bamboo has been used, and plastic bottled / jugs have been recycled for the floats. The repair costs may be high as the product is makeshift, and thus could easily fall apart due to the elements.

Customer Reviews:
No customer reviews as the product is new and is not targeted at consumers, but rather international organizations and governments.

Functional Explanation:
The bottom of the floating garden contains plastic floats that allow the garden to float above the water, and also contains a bamboo structure. When a flood comes through an area the plants and the floating garden is able to float above the water thud prevent the crops from getting damaged due to the large amounts of water.

Sustainability:
The floating garden is made from bamboo, which is a very sustainable wood to use as it able to grow in a large range of climates and grows quite easily. It also grows very quickly compared to other woods and so is difficult to illegally cut down at a profit, it also means that using bamboo does not impact the environment by a large amount as the bamboo can easily be replenished. The plastics floats have firstly been recycled, and secondly can easily be recycled to be used in new products.

Consideration of Innovation:
From the image we can see that it is hand-built meaning it took a lot of time, this can be problematic during monsoon season, where heavy rains can start instantly and are constant with extremely high winds and vast amounts of water. This means that the rafts need to well-built and hard-wearing.

One solution would be to create rigid modular sized floating platforms that are able to be connected to form a large floating platforms. This means creating a garden will be much easier and cheaper due to mass produced standardized platforms, in which economies of scale can be exploited. If the platforms are modular, it can significantly reduce the amount of time needed to deploy them and in turn can mean that more crops are able to be protected in countries effected by climate change.

Perhaps using 3D printing to produce complex and one-off shapes of floating gardens on demand could also mean that costs could be reduced, and thus project could reach a larger range of people. One problem with this is that complex technology would need to be installed in different fabrication centers around the world to allow the product to reach areas in need while keeping the carbon footprint low. So maybe a surveyor will go to an area that is vulnerable and note down the shape of land that needs to be protected against flood water, this shape can then be relayed to a 3D printing fabrication center which can print the required shape in small sections which can then easily be transported to the surveyed land.

(13) Refined Product Analysis (Continued)

Tree Mounted Wildfire Sensor:

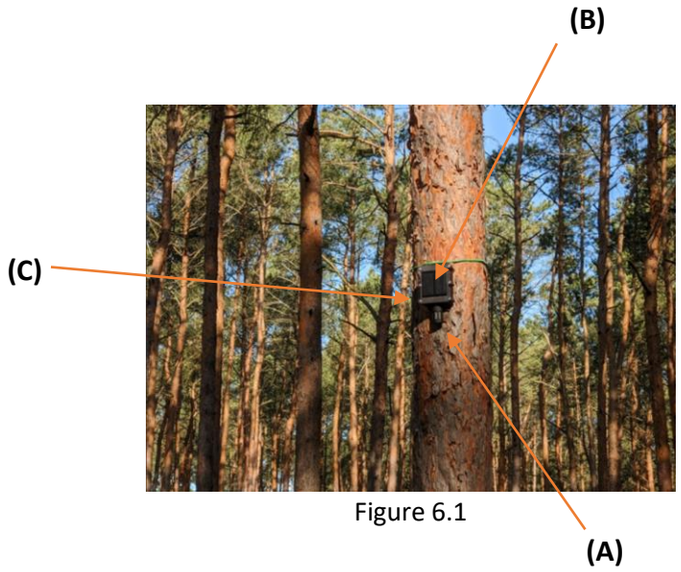


Figure 6.1

Aesthetics:
For the target audience, and the usage of the product the appearance of the product does not matter as much compared to its main functionality which is to detect wildfires before they become large. It also has a mostly industrial look with a black exterior, and a black solar panel. It also has a mesh towards the bottom. From first looks device is made mostly from plastics. It also has holes for six large bolts.

Materials and Components:
The design is composed of a 6 main components, the casing, the solar panel, the antenna, a control board, a CO_2 sensor, and a temperature sensor. This device is meant to be produced in the thousands and installed on every second or third tree, this allows the devices to act as a "hive-mind" and cover the entire forest in a blanked of fire safety. The control board is an embedded system meaning it is specifically designed for executing one task extremely reliably and quickly, one problem with this type of board is that if the firmware needs to be updated to increase the functionality of such sensors, then it would be very difficult due to the small amount of flash memory available and the restrictive CPU on the board that was only built for certain tasks. Towards the bottom of the device is a mesh (A) this mesh serves as a dual purpose: the mesh acts as an antenna and acts as a protection against the weather for the CO_2 sensor and the temperature sensor. The antenna is required so that the device can send data to the other devices nearby so that all the devices are interconnected, as said before this forms a "hive mind" where if one of the devices fails the other devices will know and will alert technicians, also this allows the network to continue working even if some of the devices are out of service. This interconnectedness allows forest managers and fire services to connect to the network easily and check the status of all the devices and if there is a fire or not. To reduce the carbon footprint of producing these devices a solar panel (B) has been installed, it also makes installing these devices in a forest much easier and quicker so that deploying these products to different forests will be easier. The casing (C) most likely has been made of polypropylene and has been injection molded so that the product is able to be mass-produced cheaply.

Performance Requirements:
The device will be subjected to high temperatures when there is a fire, snow, low temperatures, rain, wind, and possibly animals. This means the device needs to be withstand the snow and the rain without the components getting wet, the device also needs to be place higher up on trees so that it cannot be damaged by animals, and the plastic casing also needs to be able to withstand high temperatures. The product should also be drilled into the tree so that it does not damage the tree while having a secure hold so that it cannot be knocked off by wind.

Cost:
The product looks like it has been designed to keep costs down as it is supposed to be produced in the thousands for deploying to different forests around the word. The usage of injection molding and plastic also significantly lowers the cost. The main cost of the product comes from the solar panel, sensors, and microcontroller. The cost of a single device should be relatively low but installing into extremely large forests can be costly as you will needs thousands of devices. The devices also looks robust meaning repair costs will be low.

Customer Reviews:
No customer reviews as the product is new and is not targeted at consumers, but rather international organizations and governments.

User Requirements:
This product is useful as it can prevent wildfires from the root, this in turn contributes less carbon dioxide towards climate change, saves lives, reduced property damage, and saves wildlife. A reduction in carbon emissions will reduce rising sea levels, drought, extreme weather, etc.

Consideration of Innovation:
The product is innovative, it firstly does this by addressing a problem which has been a very large around the world. It also uses IoT (internet of things) which again is also very new and under development. For this product to exist many previous innovations must have happened, some examples include solar panel advancements, battery advancements, microchip advancements (so that they are faster, smaller, and more efficient), communication advancements, etc.

Sustainability:
The product's casing is made from polypropylene which can easily be recycled, but the electronic components will be difficult to recycle if at all, but these components are usually long-lasting meaning their carbon footprint will be low. The product also does not use any exterior power, thus meaning is more sustainable as it will not use coal, oil, gas.

Functional Explanation:
The product has two sensors, a CO_2 and a temperature sensor which if there is a fire nearby can detect it and send a signal to firefighting / emergency services. This is much faster than using satellite photos or Fire watch towers as they can take days for a fire to be noticed. In 2020 alone wildfires produced 400 million tonnes of carbon dioxide. The smaller the fire the easier it is to put out, and thus reduces the amount of carbon dioxide expelled to the atmosphere and thus a lower contribution towards climate change.

(14) Refined Product Analysis Summary

Introduction:
In this section I plan to identify the strengths (pros), weaknesses (cons), and inspirations I can take from the previous product analysis. This in turn will help me better design my products, which in turn will help me avoid the common problems that other products have thus increasing the product's effectiveness.

Conclusion:
After completing this section, I have identified common pitfalls that the products suffer from, I have also identified certain aspects of the products that I could use for my product. The pros, cons, and inspirations I can take will help me design a good product in the designing stage.

Moving Forward:
Next, I plan to complete a materials analysis where I will analyze the disadvantages and advantages of certain materials that I may use in my designs. This in turn will aid me when choosing materials in the design phase.

Mountain Fog / Cloud catcher:

Pros	Cons	Inspirations
Robust design- the product is long-lasting and has been built with strength in mind.	Very Specific net- the net used in the product is very specific and thus has a high carbon footprint and is difficult to source	Modularity- the design is modular and so is easier to increase the capacity, or to move around. I could use this in my design as it would increase the range of people that this product can be given to, thus increasing its overall impact.
Standardized components- the product is mostly composed of standard sized aluminum pipes, and cable ties.	Non-centralized collection system- the water collection system is composed of a few small water tanks instead of a large centralized one, this increases complexity, and thus increases points of failure	Standardized Components- the design contains mostly standardized sizes, ex. Standard cylindrical aluminum extrusions, and metal zip ties. I should use this in my own designs as it will reduce costs, aid repairs, and reduce the overall complexity of the design.
Modularity- easy to adapt to a large range of possible target markets. More adaptable so that capacity can easily be increased to suit different regions in the world.		Robust Design- this increases the lifetime of the product, and thus increases the sustainability factor of the product. I should consider this as the product will last long and thus will have a smaller footprint.
		Centralization- I should also consider the overall complexity of the system by making my product more standardized, and more friendly with each other so that they are able to work together easily. This will increase the adaptability of the design to different regions and target markets.

Floating Garden:

Pros	Cons	Inspirations
Simple Design- This reduces costs as the overall design does not include any unnecessary components and materials. This makes the product more economical, and also reduces costs.	Makeshift- this makes the product last for less time and also increases costs.	Low costs- I should aim to make the product efficient, meaning nothing unnecessary is included, this will reduce costs making it easier for the product to reach those in need. Modularity- perhaps use modularity to allow the device to be transported from A to B easily Design for Disassembly- Design the product with as minimal processes and the least complexity as possible so assembly and disassembly is considered and easy without compromising other aspects of the design.

Tree Mounted Wildfire Sensor:

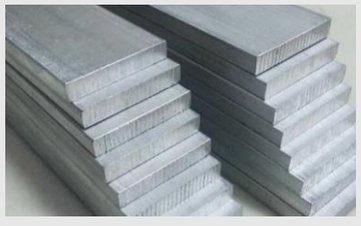
Pros	Cons	Inspirations
Hive mind- the product's reliability is increased as each of the different devices are able to support each other.	Difficult to recycle- The product is composed of large amounts of electronic components meaning it is difficult to recycle as these components contain large varieties of different compounds.	Recyclability- I should try and limit the number of materials in my product so that it is easy to recycle and should also try and avoid using electrical components as they are extremely difficult to recycle.
Injection Molding- the product's casing is made from injection molding meaning that it is easier to make and thus the product will be cheaper		Efficient Processes- I should try and make sure that my products' components are produced through effective means of production. This will make the product cheaper and thus more economical, this will also reduce the carbon footprint as less energy will be used in production
Innovative- the product contains a large number of electronic components that are first of their kind, and that are also		

(15) Material Analysis

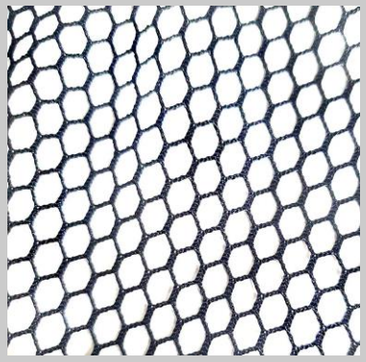
Introduction:
In this section I plan to analyze different types of materials that I may use in my final design and product. I have decided to analyze these materials as I have identified them in my refined product analysis and believe that these materials will be the most used in my project.

Conclusion:
After completing this page, I have a better understanding of which materials should be used when, this in turn will aid me when designing my product as it will allow me to reduce the amount of trial and error between my prototypes. I also have a better understanding of the different materials that exist and the different usages and properties they have. For example, I know that PVC has a very low melting point, and that stainless steel is actually quite expensive.

Moving Forward:
Next, I plan to complete a lifecycle analysis, where I will talk about the different stages of a given product's life, I plan to mention raw material extraction, material processing, manufacturing, distributing, usage, and disposal / recycling. This in turn will help me better design my product so that it has a smaller carbon footprint and is thus more environmentally friendly. This is especially important for my product as its main aim is to combat the effects of climate change / climate change.

Material	Advantages	Disadvantages	Overall Opinion
Stainless Steel 	Strong- high torsional, tensile, and compressive strength Hard- difficult to scratch and dent Rigid- very rigid meaning it does not bend easily	Expensive- makes the product cost more Heavy- difficult to carry to remote areas, increased carbon footprint Ferrous- can rust in rain or in snow reducing structural integrity	Although the stainless steel is expensive, it is very strong and can be milled in many ways. It is a good material if not exposed to water as it can rust, it is also not suitable for remote areas as it will be very heavy. The material is also hard, and so does not scratch or dent easily. Overall, this is not a suitable material.
Aluminum 	Strong- high torsional, tensile, and compressive strength Non-ferrous- cannot rust in rain or snow, retaining structural integrity Light weight- makes it easier to carry to remote areas, and reduces carbon footprint when being shipped	Expensive- makes the product cost more Soft- can be scratched, and dented	Aluminum, although expensive, is also very strong and rigid, this makes it easy to carry to remote areas and reduces its carbon footprint. This materials is ideal as it is cheaper than stainless steel while still being strong enough for its usage, it also does not rust which is very important as it is exposed to the elements almost every day. Overall, this is a suitable material.
PVC 	Cheap- PVC is a relatively cheap plastic Rigid- PVC is very rigid, meaning it will not flex easily in high winds Hard- difficult to scratch and dent Brittle- can be damaged by hailstorms, or by larges forces, also can snap if winds are too high Light weight- makes it easier to carry to remote areas, and reduces carbon footprint when being shipped	Low temperature resistance- PVC piping cannot be used safely at more than 60 °C Unsustainable- PVC is made from crude oil which is non-renewable	PVC is cheap, it is also lightweight reducing carbon footprint and making it easier to carry to remote locations. It is also very rigid meaning it will not flex in the wind. The major problem with PVC is that it has a low temperature resistance and so is unsuitable for products outside in the sun. It is also made from a non-renewable resource. Overall, this is a suitable material, as long as it is not being used as structural supports.

(16) Material Analysis (Continued)

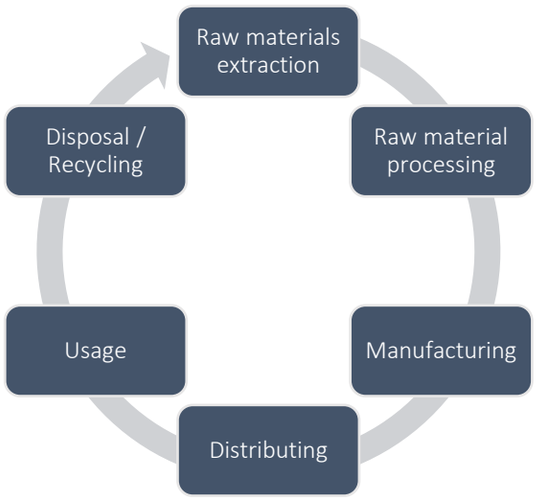
Material	Advantages	Disadvantages	Overall Opinion
Polyester Hex Mesh 	Strong- polyester also does not rip easily, and thus can handle high winds, and hailstorms Low elasticity- It does not stretch that easily, and thus meaning it hand stay rigid in high winds Cheap- polyester is a very cheap plastic High temperature resistance- polyester can handle up to 265 °C, this is good as it may be exposed to sunlight for many hours Desirable shape- The hex shape increases the amount of water that can be caught from the air	Unsustainable- polyester cannot be recycled easily after the 4th or 5th time of recycling, polyester is also made from crude oil which is non-renewable	Polyester Hex Mesh is extremely cheap as it is one of the easiest to produce plastics. It also has a low elasticity and so will not stretch in the wind, thus increasing water yield, it also has a high temperature resistance and so is suited for outdoor use. It also has a desirable shape which will increase of the amount of water caught from the air. The hex mesh can come in different sized hex holes, these holes can be layers to increase the amount of water caught. Overall, this is a suitable material due it it's shape.
Pine 	Cheap- relatively cheap compared to metals, thus reducing overall product cost Rot Resistant- does not rot easily, so structural integrity is retained Resists Shrinking and Swelling- can handle snow and rain without changing shape Light weight- makes it easier to carry to remote areas, and reduces carbon footprint when being shipped Sustainable- Grows quickly	Soft- can be scratched, and dented Slightly Flexible- this can be a problem in high winds as it may change the shape of the product permanently reducing its effectiveness.	Pine is cheap as it grows fast, this makes it sustainable and thus more environmentally friendly. It is cheaper that metal alternatives while still being light weight, not brittle, and strong. It also resists shrinkage which means it does not change shape easily in humid environments. Pine is also rot resistant meaning it is long-lasting One problem with pine is that it is slightly flexible which can be a problem as it may change the shape of the mechanisms thus making them unusable after years of usage. Pine is also soft and so can be scratched and dented easily. Overall, this is a semi-suitable material as it is not as long lasting as metals but is cheap.
Bamboo 	Cheap- relatively cheap compared to metals, thus reducing overall product cost Rot Resistant- does not rot easily, so structural integrity is retained Rigid- very rigid meaning it does not bend easily Resists Shrinking and Swelling- can handle snow and rain without changing shape Light weight- makes it easier to carry to remote areas, and reduces carbon footprint when being shipped Sustainable- Grows quickly	Soft- can be scratched, and dented	Bamboo is extremely fast growing and is thus very sustainable, also once dried it is very rigid, and does not flex easily. It also resists shrinking and swelling, thus cannot change shape easily. Bamboo is also lightweight and is thus easy to carry to remote regions, and also has a low carbon footprint. It is rot resistant and thus lasts longer. Overall, this is a semi-suitable material as it is not as long lasting as metals but is cheap.

(17) Lifecycle Analysis

Introduction:
In this section I plan to analyze the lifecycle of a chosen product, I will talk about raw material extraction, material processing, manufacturing, distributing, usage, and disposal / recycling. This in turn will give me a better understanding on how to create a product that is environmentally friendly.

Figure 7.1

Stages of the lifetime of product in Figure 7.1



Raw materials extraction:
The major materials of product 7.1 are: aluminum, plastics, and concrete

1) Aluminum
   Here aluminum is made from two different sources, one being ore extracted from the ground, and the other being recycled aluminum from car parts, drink cans, food containers, etc. On average about 80% of an aluminum bar is made from recycled aluminum while the other 20% is extracted from ore. Recycling aluminum is very efficient as aluminum has a relatively low melting point of 660.3°C compared to the ~1450°C of steel, this means less energy is required to melt the aluminum into new components, also aluminum is pretty light meaning it is easy to transport with a low carbon footprint thus being more sustainable. Aluminum is also 100% recyclable meaning that no metal is lost during melting. A problem with ore aluminum is the way it is extracted from the ore, since aluminum is more reactive than carbon (in the reactivity series) aluminum cannot be extracted through a displacement reaction. This means expensive electrolysis must be used, this is expensive as it uses a lot of energy and also requires advanced machinery. Another problem with this large amount of energy may come from non-renewable sources which damage the environment such as coal. Also, when extracting ore from the ground it will requires huge mines as a small percentage of aluminum is actually present in ore, meaning a large number of ore needs to be mined to make even a little aluminum. Mines cause a lot of pollution in the form of air, water, and sight. They are an eyesore and also destroy habitats as they need space to mine. They also pollute the water and air as heavy metals may leech into the water supply or large amounts of natural gas may leak out into the environment.

2) Plastics
   Plastics are made from the polymerization of organic chemicals such as alkenes extracted from crude oil. Making plastics requires a lot of energy as to extract any useful compounds from crude oil it has to go through the process of fractional distillation where different sections of a fractionating tower are heated at different temperatures to separate the fractions (compounds) according to their boiling points. This large amount of energy may come from non-renewable sources which damage the environment such as coal.

3) Concrete
   Concrete is a composite material composing of, sand, aggregate, and cement. A major problem with concrete is that once set concrete releases greenhouse gases in the process. This can be a problem as it contributes to climate change. To increase the strength of the concrete in tension, rebar, or steel rods are added. The contribution of greenhouse gases is relatively small and should not be a concern in this case as small amounts of concrete are being used

Raw materials processing:

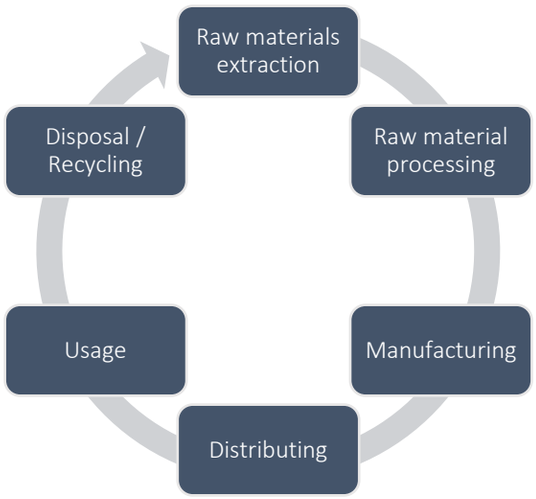
1) Aluminum
   For the aluminum rods the aluminum is extruded through a die where it forms a pipe. For the cable ties the aluminum is rolled into flat sheets and then pressed through a hydraulic press which cuts holes and folds them metal to make it thicker in some places. The aluminum cables are made from very long aluminum wire strands which are then twisted in bundles to form a rope. All of these require large amounts of energy as the machinery needs to run high-power hydraulic pumps to apply sufficient force to the aluminum to shape it into the various forms, and also require energy to heat the aluminum to make it malleable.

2) Plastics
   For the plastic tanks it is most likely made through injection molding. This process is very efficient as it can product hundreds of molded parts in a short amount of time, it also requires less energy as plastics do not melt at high temperatures.

(18) Lifecycle Analysis (Continued)

Figure 7.1

Stages of the lifetime of product in Figure 7.1



Manufacturing:
In figure 7.1 most of the components are assembled through bolts, meaning there is no welding or fixed joints. This is good as welding produces large amounts of toxic gases and is also dangerous for the operator meaning it is unethical. Also, the cable ties are manufactured through sheets of steel that are passed through a hydraulic press meaning that large numbers can be produced quite efficiently as it does not require that much energy per part. The product mostly involves 2D aluminum and aluminum pipes that have had holes drilled in them for bolts and fittings, this means that there is not a large amount of energy used in manufacturing as the product will be assembled on site. The net is made through a special machine in which a net is molded in two sections and strands between the two layers are woven in, the machine is extremely specialized meaning it will raise costs of the product and will also mean that it will increase the carbon footprint of the product as it is only able to be produced in certain factories.

Distributing:
The product will be transported to many regions in the world, the product has been designed with lightweight-ness in mind, as it uses a lightweight plastic for the net, and aluminum which is a lightweight metal. This means that it does not require large amounts fossil fuels to be spent moving the product around the world. The product will also be unpacked and will be assembled on-site meaning that its package is relatively small, thus reducing the carbon footprint of said product, as the product will compacted into a small package.

Usage:
The product is built to be long-lasting meaning that it will most likely not have to be recycled and will continue to be repaired throughout its lifetime, and when it finally reaches the end of its life it will need to be recycled. The product will be exposed to the elements almost daily, including harsh weather, cold, heat, etc.

Disposal / Recycling:
The product is composed of mostly rudimentary materials meaning that it will be easy to recycle. The concrete base could be used in the future for a new water harvester, or as a foundation for homes or buildings.

The aluminum can easily be recycled by being sent to a metal works where they will be able to heat the metal up to be used for new purposes. Aluminum is easy to recycle as it is cheaper for manufacturers to buy recycled aluminum as electrolysis is expensive.

The plastic may be more difficult to recycle, but since it is only composed of one type plastic making it easier. This is especially true if the net is made from a common plastic such as Nylon.

Conclusion:
After completing this page, I have a more complete understanding on how to design products so that they have a small carbon footprint. This in turn will increase my product's effectiveness at combating the effects of climate change / climate change.

Moving Forward:
Next, I plan to complete a sustainability and ethics analysis, where I will talk about how I could avoid unethical and unsustainable sourcing of materials, manufacturing of materials, energy needed to manufacture such materials, and manufacturing my product.

(19) Sustainability and Ethics Analysis

Introduction:
In this section, I plan to complete a sustainability and ethics analysis, where I will talk about how I could avoid unethical and unsustainable sourcing of materials, manufacturing of materials, energy needed to manufacture such materials, and manufacturing my product. This in turn will help me design my product in such a way as to not use difficult or unethically and unsustainably sourced materials, and to make sure the product is manufactured ethically and unsustainably.

Conclusion:
After completing this page, I have a better understanding of which materials I should avoid and what materials should be used. I also have a better understanding of why to avoid unethical and unsustainably manufacturing, sourcing, processing, and distribution

Moving Forward:
I have now completed my investigation phase of my project, next, I plan to complete a thorough and comprehensive design brief and specification. This in turn will help me create designs that help me solve my chosen design context effectively, and successfully.

Sustainable Sourcing of Materials:
Materials should also be sustainably sourced, meaning in the way they are mined / extracted from the environment should leave the environment in the same condition if it was found, or if not in a better condition. Materials should also be sourced in such a way that they are able to last for the next generation of human's usage, and not just for the current generation.

Problems with unsustainable sourcing of materials include:
(1) Habitat Destruction
(2) Polluting of local water supply
(3) Air pollution
(4) Desertification
(5) Global Warming

The forestry stewardship council (FSC) (figure 1.3) are a company that certifies sustainably managed forests and allows them to sell under the FSC seal of approval, FSC makes regular inspection to make sure that forests are grown sustainably, are harvested safely, and are replanted. I should ensure I source timber for my products from them as it makes sure my prototype does not contribute towards above problems.

The aluminum stewardship initiative (ASI) (figure 1.1) is a company that certifies sustainably sourced aluminum. I should make sure I source aluminum for my product from sources certified by them as my product may contain large amount of aluminum which could be contributing towards the above-mentioned problems, they aren't sustainably sourced. They specialize in aluminum production and sourcing, they make sure mines and metal works are safe, use recycled aluminum as much as possible, and do not impact the environment.

Ethical Sourcing of Materials:
Materials should be sourced from a reputable supplier, that ensures that workers receive good working conditions, humane working hours, adequate pay that allows them to support their families. This means that people are not exploited in the sourcing of raw materials of products, and thus makes all parts of selling and buying goods a win win for all stakeholders. Women and children are specifically vulnerable to being exploited by foreign companies looking to maximize profit.

This is especially true with my prototype as it is aimed to help those vulnerable due to climate change.

Fair trade (figure 1.2) is a company that makes sure workers receive all of the above rights they are entitled to while working under foreign companies. They also invest in local communities by developing schools, libraries, and hospitals in the area around a workplace to help benefit the local community and local workers.

FAIRTRADE

Figure 8.2

FSC
FSC™ C110879

Figure 8.3

asi Aluminium Stewardship Initiative

Figure 8.1

What is sustainability?:
'sustainability is the ability to maintain something at a certain level' In other words it means to manufacture / source materials that are made in such a way that as little as possible waste is produced, or the least possible impact to the environment / people. This also makes sure resources are preserved for future generations.

What are Ethics?:
'Ethics are moral principles that govern what is good or bad', meaning ethical manufacturing / sourcing of materials are where the workers who carry out these tasks are treaty fairly, meaning the receive an adequate pay, good working conditions, proper safety, training, etc.

Sustainable Manufacturing:
I should aim to make sure my manufacturing has a small carbon footprint, meaning the processes I use should be efficient, and that materials should be shipped through routes such as container shipping, or are locally sourced. I should also make sure that the energy sources that run my processes are clean and have almost no carbon footprint, meaning they don't contribute towards the problems mentioned before. I should perhaps use wind, or solar in the manufacturing plant as it will reduce the carbon footprint of my product compared to using oil, gas, or coal power sources.

Ethical Manufacturing:
I should aim to make sure that workers who produce my product should be adequately paid, have good working conditions, work humane hours, and receive support when needed. This makes sure that they are able to support their families and are not exploited.

If I unethically manufacture my product could lead to:
(1) Poverty
(2) Regional Instability
(3) Loss of Peace
(4) Violence
(5) Exploited workers

(20) Design Brief

Introduction:
In this section, I plan to identify and summarize what I have learned from the investigation, identify my final design problem, my final target audience, and then the final Design brief.

Design Problem:
During the last 3 decades fossil fuel burning, and sources of energy produced from fossil fuels has been on the rise. This huge rise has caused massive increased in the amount of greenhouse gases in our atmosphere, resulting in climate change. This climate change has been causing a variety of problems such as, rising sea levels, drought, flooding, adverse weather and so on.

Target Audience:
II will be designing a prototype to support those vulnerable because of one of the problems caused by climate change. My target audience will be people of all demographics as the prototype will be designed to support those in need no matter their demographics.

Design Brief:
I will design and manufacture a prototype that is used to support vulnerable people. The function of the product will be to assist people in their daily lives who are affected by climate change. The product should tackle situations arising from rising sea levels, drought, flooding, adverse weather and so on.

Conclusion:
After completing this section, I have summarized what I have investigated in the previous sections which will allow me to justify my points in the design specification.

Moving Forward:
In the next section, I plan to complete a design specification on the next two pages detailing the points that my prototype will need to fulfill, a justification of these points, and how I will test this point in the evaluation phase. I plan to talk about Form, Function, User Requirements, Performance Requirements, Materials and Components, Scale of Product and Cost, and Sustainability.

Research findings:
From my research in the investigation phase I have found out the following:

(1) I know what my design context question is specifically asking of me, I have thoroughly researched what exactly is meant by "vulnerable people" and "supporting people", I have also analyzed some examples of products that vulnerable people support people. This has helped me understand what the design context is asking, and thus begins to make me think of some design ideas.

(2) I have also completely researched the different categories of vulnerable people which has helped me identify potential categories of people I could design products for, and thus helps me narrow down my target market. The categories I have identified here are, the elderly, neurodiversity, and those effected by climate change.

(3) I have completed a product analysis where I chose a broad range of products to analyze, I have talked about how the product works, its potential problems, and potential solutions / improvements for the product. This in turn has helped me narrow down my target market into two categories, the elderly, and those effected by climate change

(4) I have conducted an interview in a person who is elderly and have also created a persona that is affected by climate change. In this section I have identified the possible needs and what's of said people and have also identified possible design possibilities.

(5) Here, I have identified the different problems associated with climate change, this has helped me identify some design possibilities for my project

(6) Here, I have outlined the questions I should be asking in order to thoroughly analyze 3 products, I have talked about Aesthetics, Sustainability, Consideration of Innovation, Materials and components, Performance Requirements, User Requirements, and Customer Reviews. This in turn helps me figure out the common problems, and inspirations I can take from common products that support people effected by climate change.

(7) In this section I have summarized the pros, cons, and inspirations I can take from the 3 analyzed products. And this in turn will help me effectively create design ideas.

(8) Here, I have analyzed the commonly occurring materials in the previously analyzed products, I have identified some suitable materials I can take forward in my designs and have found some unsuitable materials I should not use.

(9) Here, I have talked about the lifecycle of a product and how it effects the environment, this help me design my product so that it takes these considerations into account.

(10) In this last section of the investigation phase, I have identified a range of ethical and environmental problems when sourcing and manufacturing materials. This will help me design my product so that it takes these problems into account. I talked about how I could avoid unethical and unsustainable sourcing of materials, manufacturing of materials, energy needed to manufacture such materials, and manufacturing my product.

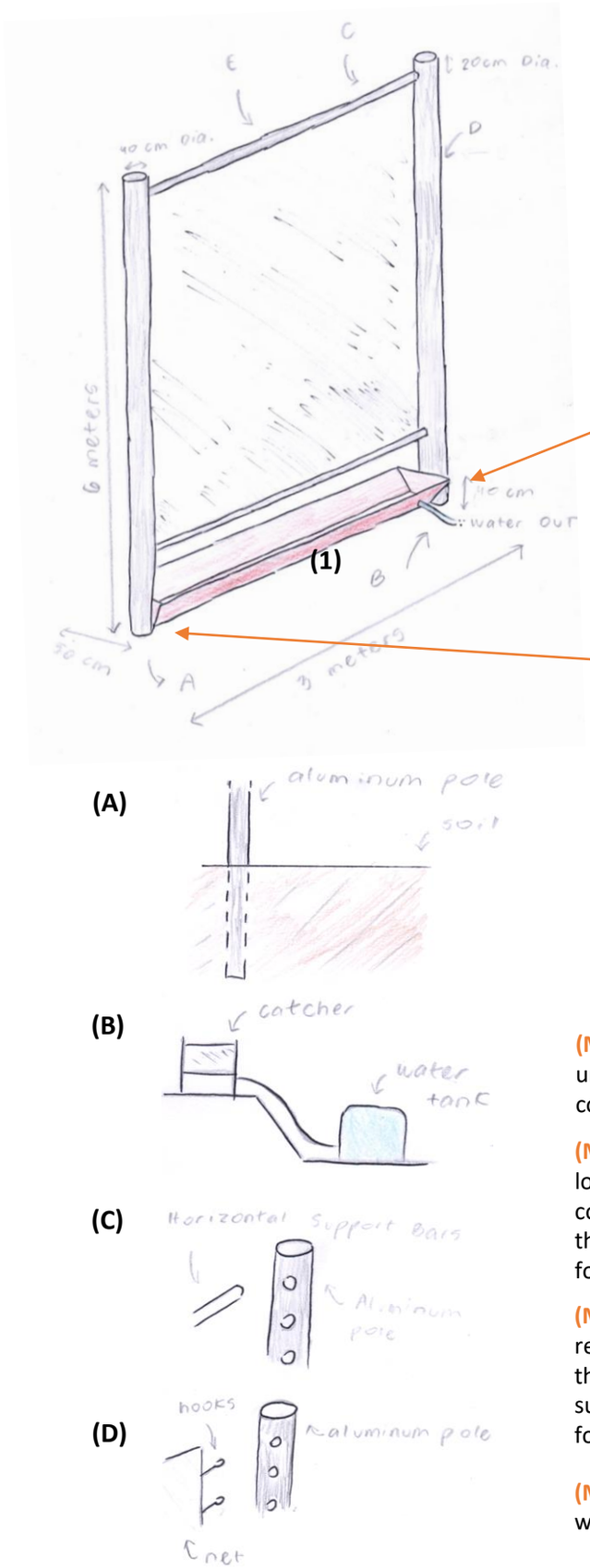
(21) Design Specification

Area	Specification point	Justification	Testing
Form	1.1a The product (when packaged compactly) should be smaller than 1.5 meter cubed. 1.2a The shape of the product should have ergonomic grips. 1.3a The aesthetics of the product should be complimentary to the local environment.	1.1b This is because the product will be installed in rural areas meaning it will need to be small to aid shipping. The product should also be small so that it reduces its carbon footprint. In my customer interview my client also wanted me to make sure the product was sustainably sourced 1.2b This will allow it to be transported easily to remote areas. The prototype is going to be produced for those vulnerable due to climate change as stated in the design brief. 1.3b This will prevent the product from ruining the local landscape and preventing it from being an eyesore.	1.1c I can quantalively measure this by using a ruler where needed and calculating the volume the product takes up. 1.2c I can give the product to a focus group and ask them on their feedback on the comfort of the grips. I could also make people hold the product for 5 minutes at a time and ask them if it was easy or difficult to do so. 1.3c I can take pictures of the product in different backgrounds and ask a focus group if the product sticks out or blends in. I can also visually check if it blends in or doesn't.
Function	2.1a The product must be able to complete its main function without mains electricity. 2.2a It could be modular / adaptable. 2.3a It must provide relief or support the chosen demographic from climate change. 2.4a It should act as innovative product to promote sustainable lifestyle among the community.	2.1b This is because the product may be installed in rural areas, and thus there may not always be electricity available. My client also wanted to make sure the product was not electrically powered. 2.2b From my client interview and product analysis I have seen the technique of modularity. I should consider this in my design as makes it so that the product can be expanded to increase yield, or to increase reliability. This means it can support a wider range of people in different locations. 2.3b This is the main function of the product and should be completed effortlessly. 2.4b This reduces the carbon footprint of the world which in turn reduces the impact of climate change My client also stated he would like the product to be sustainable.	2.1c I can visually check this and see if the product works without and electricity. 2.2c I can visually check and analyze if the product is truly modular and is able to adapt to different usages 2.3c I can ask my target market, or ask a focus group a series of questions regarding this and thus assess whether it meets this criteria 2.4c I can ask my target market, or ask a focus group a series of questions regarding this and thus assess whether it meets this criteria
User requirements	3.1a Should be easy to assemble, preferably with no specialist tools. (Design for assembly) 3.2a The product should also have a user manual 3.3a The product could have an educational guide on climate change 3.4a The product must be intuitive to use. 3.5a Instructions should be visual and language friendly.	3.1b Since the product is being assembled it remote areas (as those are the areas usually affected the most by climate change and have the least access to aid) it will increase reliability, reduce repair costs, and make it easier to deploy. 3.2b This will make it easy to assemble, and complete repairs on the product to make sure it runs optimally. 3.3b The guide could function to educate people about the effects of climate change. It could also contribute towards a local school library so the diagrams should also be appropriate for children. 3.4b This will reduce the chance of installing the product wrongly, increasing the products lifetime, and also making it easier to install. 3.5b This will make it easier to distribute as the manuals will not have to be translated. This also reduces the chance of confusion.	3.1c I can time how long it take an average person to assemble it and if it is intuitive. I can also ask a focus group to assemble this and judge how much they struggle and how long they take. 3.2c I can ask a focus group who speak different languages to assemble the product through just the manual 3.3c I can ask a focus group of children ages between 5 to 15 and asked them their thoughts and feeling, and assess how much they enjoy / are engaged by it 3.4c I can ask a focus group to assemble the product and assess how they assemble it and if there struggle with any aspects, I could also ask for their thoughts and feelings 3.5c I could create and online poll and ask people to rate how easy it is to understand through asking a series of questions related to its content.

(22) Design Specification (Continued)

Area	Specification point	Justification	Testing
Performance requirements	4.1a Must be durable and survive extreme weathering. 4.2a Should be able to support its own weight. 4.3a The product should weight no more than 20kg.	4.1b This will reduce repair costs and will also make it more survivable to freak storms allowing it to be deployed to large range of regions. 4.2b This allows the product to be a standalone piece, meaning it won't need any extra support to run properly. 4.3b This will mean that the product is easy to transport to remove areas without being a burden or causing issues.	4.1c I can expose the product to large forces, and also assess whether the materials will be able to last. 4.2c I can assembly the product and allow it to stand on its own for a few days, and then assess whether it is stable or not. 4.3c I can measure the weight using a mass scale.
Material and components	5.1a Must include non-permanent joints for easily assembly and disassembly. (Design for assembly) (Design for Disassembly) 5.2a Materials should have properties that are relevant and make sure the product is easy to assemble (Design for processing) (Design for assembly) 5.3a The product should include standardized parts to aid easy repair and reduce costs.	5.1b Makes it easier to repair, and also make it so the product can be moved to increase its performance. My client says he would also like to be independent when maintaining the product, meaning the product can easily be installed and removed by one person. 5.2b My client has also made sure the product it easy to assemble as he has said that the product must be able to assembled by one person, so he is able to remain independent. 5.3b My client also has stated that he would like the product to be easy to repair by using standardized parts meaning it will be easy to source replacements when needed.	5.1c I can assembly and disassemble the product multiple times and assess whether this is true. 5.2 I can assembly and disassemble the product multiple times and assess whether this is true. 5.3c I can compare the parts used and search in local and online shops for such parts and check whether the parts I have used are available and are from a standardized system, ex. Metric screws.
Scale of production and Cost	6.1a The product could be mass produced. 6.2a The product could be batch produced. 6.3a The prototype should have simple design, and include ideas such as snap-fit (Design for assembly)	6.1b Here economies of scale could be exploited to reduce costs making it more affordable for those regions in poverty. Quality may suffer from this method. 6.2b Here economies of scale could be somewhat exploited so costs would not be that high. This method would have a higher quality than that of mass production. 6.3b This will reduce the chance of error when assembling the product, will make it faster, and will also make it easier to repair as part counts are reduced.	6.3c I can give the product to a focus group and ask if the design is easy to understand, I can also assess whether the product is easy to assemble and includes sections that take the user into account.
Sustainability	7.1a Materials must be sustainably sourced. 7.2a Materials and components must be ethically sourced and produced. 7.3a The materials should be easy to recycle using a lack of adhesive and more non-permanent joinery methods. (Design for disassembly) 7.4a The product must be long lasting	7.1b In my interview I have found out that my client would like a product that is sustainably produced. Also, from by sustainability analysis I identified that the product should be produced in a way that does not cause the large number of problems mentioned there. 7.2b Components, materials and the product itself should be ethically sourced and produced, meaning they do not exploit or take advantage of anyone. If I don't do this it could lead to the multitude of problems mentioned in the sustainability and ethics analysis. 7.3b This will mean the product is easy to repair and if disassembled can be reassembled when needed thus reduced the waste produced. 7.4b This will prevent any unnecessary waste as the product will not need to disposed of only recycled, and since the product may be installed in a remote region getting a replacement may be costly and may have a large carbon footprint.	7.1c I can assess whether the sources I have sourced the materials and components are sustainable through research. 7.2c I can assess whether the sources I have sourced the materials and components are ethical through research. 7.3c I can assembly and disassemble the product multiple times and assess whether this is true. 7.3c I can expose the product to large forces and assess whether the materials are able to last a lifetime's worth of wear.

(23) Initial Design Ideas (Water Catcher)



(Functional Explanation) The prototype works by catching water using its net, the water then falls down into the red catcher bin, then it is piped to a collection tank for usage.

(Performance Requirements) The product will be exposed to large amounts of water and abrasive dust meaning aluminum is suitable for this case. The prototype will also be subjected to large temperature swings meaning the metal will expands and so slight flexibility must be built into the design to make sure the product does not slowly fall apart. This is done by using hooks and holes as mentioned before.

(Materials and Components) There will be a red plastic catcher bed on the bottom of the net which will be able to fold so that it is able to pack into a smaller package reducing costs. The plastic catcher should also have an ergonomic folded shape so when being moving it is not tiring to carry around.

(User Requirements) Once the water is in tank it can be treated with chlorine tablets to make sure that the water is clean and safe for cleaning, drinking, cooking, etc.

(Cost) (Sustainability) Aluminum is being used throughout the prototype to firstly make the product lighter (thus reducing carbon footprint), and to secondly preventing corrosion making the prototype last longer and thus reduce maintenance costs. Aluminum is also easy to cut, extrude, and machine to build the components required for the prototype, this also reduces costs.

Components and materials should be locally sourced in the area of production so that the product is ethical and sustainable. It should also be produced in geographic regions where the prototype has the most need to reduce carbon footprint during transport and to provide jobs.

(Materials and Components) The pole will be partially underground to improve stability and to reduce costs as no concrete has to poured. **(A)**

(Materials and Components) The water tank will be at a lower point so water can flow from many different collectors to one point removing the need for pumps. And thus, satisfying the spec point the electricity is not needed for the man function. **(B)**

(Materials and Components) The aluminum pole will have regular holes to firstly reduce weight, then costs, and then the prototype's carbon footprint. The two horizontal support bars are permanently attached to the net, so when folded a small package is formed. **(C)**

(Materials and Components) The net will lock in the same way as the horizontal support bars through hooks. **(D)**

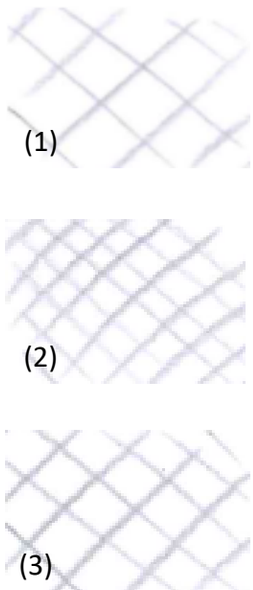


Figure 9.1

(Inspiration) Figure 9.1 shows a cloud forest where the trees act as a sort of 'mesh' where when low lying clouds full of moisture are caught in this mesh. This causes water droplets to catch onto leaves and tree trunks, then water falls to the ground and is given to the tree's roots. At this altitude, the mountains are high enough that there is no ground water, but too low for ice to form and melt to create rivers, etc. This means that these trees get water through the low-lying clouds.

Similarly, we can use this phenomenon to our advantage for communities who have low water security and have to fight for every liter of water. This is especially true for those communities in high barren mountains, or in hot and dry climates where rain is unable to fall but there are still low-lying clouds.

(Materials and Components) (Consideration of Innovation) In particular we can use biomimicry to replicate the way the leaves of different sizes and dimensions create a mesh that catches large portions of water from the air. This can be seen in the net design for this water catcher prototype where we have 5 layers of differing mesh hole sizes, the nets are also offset from one another so water will have to travel a very awkward path to not get caught, thus increasing the chances for catching said water. **(E)**

(E)

The red is the (1), coarse fishing net

The orange is the (2), coarse-fine fishing net

The green is the (3), fine fishing net

(Materials and Components) The net will be composed of standardized fishing nets. Finishing nets are used as they are relatively affordable, heard wearing, and most importantly and standardized and mass produced and so are very cheap. This will lower the final cost of the prototype.

(24) Initial Design Ideas (Hexagonal Float)

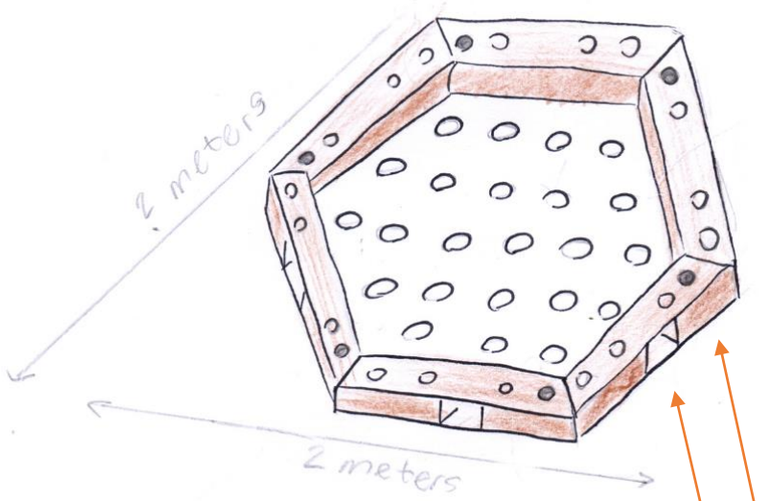


Figure 10.2, Cross-section of the hexagonal float

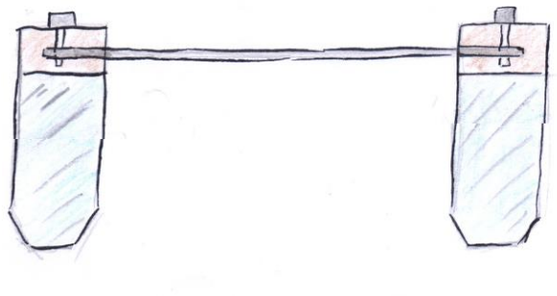


Figure 10.3, Latching mechanism

Figure 10.4 Polystyrene floats

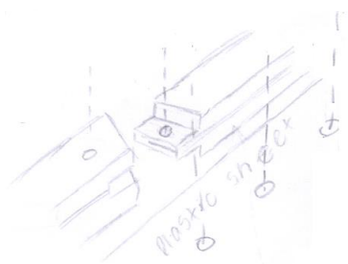


Figure 10.5 Coped Tongue and Groove joint

(Functional Explanation) This design is a floating garden in which plants and crops are able to planted into, the floats are able to latch onto each other so large fields of crops can easily be protected. Once a flood comes in the floats will be able to float thus preventing the crops from being drowned, this thus prevents the loss of crops and thus improves the food security of different communities.

(Performance Requirements) (Sustainability) The product will be exposed daily to huge temperature swings, and will be exposed to direct sunlight for hours on end, this means that the injection molding beams need to be made of plastic that is able to withstand such conditions. A prime example would be HDPE. HDPE is quite sustainable as this is because it is a relatively common plastic and is a relatively rudimentary plastic and so it is quite easy to recycle.

(Cost) HDPE, since rudimentary and common is quite cheap keeping the costs down for this device. Moreover if the pieces are injection molded it would be highly efficient and not a lot of resources or energy will be wasted whilst keeping costs down due to economies of scale.

(User Requirements) (Materials and Components) To make the hexagonal floats easy to use and deployable they are firstly made of plastic to keep the lightweight for their large size, and so they do not need any machinery to deploy. Moreover, the device contains holes to allow plants roots to poke through so that the plants are able to grow completely, and when a flood comes, these roots taken up with the hexagonal float.

However this only is possible if the soil the roots is in is lose and so the fields before installing such a protection device must be made lose by using machinery or shovels.

(User Requirements) (Materials and Components) The device contains a latching system in which there are springs and latches that have a quick release mechanism. This makes the design very quick to deploy as no nuts and bolts are needed and the sections can just be snapped together like Legos.

(Materials and Components) (Sustainability) The design is able to float by using closed-cell polystyrene floats that provide the bouncy. There are screw -in inserts placed into the polystyrene which allows the bolts from shown figure 10.5.

However one problem with polystyrene is that it cannot be composed or decompose, it is very polluting as it is very light and so can spread fast due to the wind, it can be swallowed by animals as it could be mistaken as food, and if burned it produces very toxic gases. Perhaps using an alternative foam may be better.

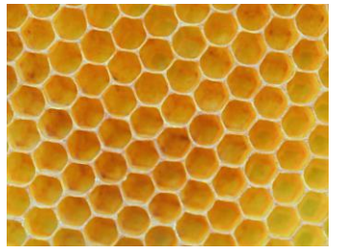


Figure 10.1

(Inspiration) Figure 10.1 shows honey bee comb. This comb is hexagonal in nature due to the efficient nature of hexagons. This means that hexagons use the least amount of beeswax but yet still have the same structural integrity of other structure types, in basics hexagons basically have the highest internal volume storage per unit of beeswax.

Similarly, we can use this shape to our advantage when design the floating crop field. Since world population is very large, and since the amount of food the world needs to produce is very large, and since crop fields susceptible to floods are on the rise due to climate change, for this prototype to be successful and adopted by farmers it needs to be extremely cheap per hexagon so it can be deployed over the vast crop fields of the world. The hexagon is the perfect shape for the float as it maximizes crop area volume per unit of material spent and so the cost protecting each kilogram of wheat is significantly lower and this thus increases the chance of adoption by farmers.

(Materials and Components) The six different injection molded sections are joined together using a 45 degree angle coped tongue and groove joint as shown in figure 10.5. The bolts used here have many purposes, one use is holding the floats to the frame, another is holding the frame together, and the last one is holding the HDPE hexagon shape with holes. This reduces the number of bolts required by the design and this thus reduces the cost of the design.

As shown in Figure 10.5 the bolt passes through the plastic sheet, and the two plastic injection molded pieces, the other end of the bolt screws into the screw-in inserts of the closed-cell polystyrene and so there is no need for a spanner here as the screw-in insert acts as a fixed one.

(25) Initial Design Ideas (Mosquito Trap)

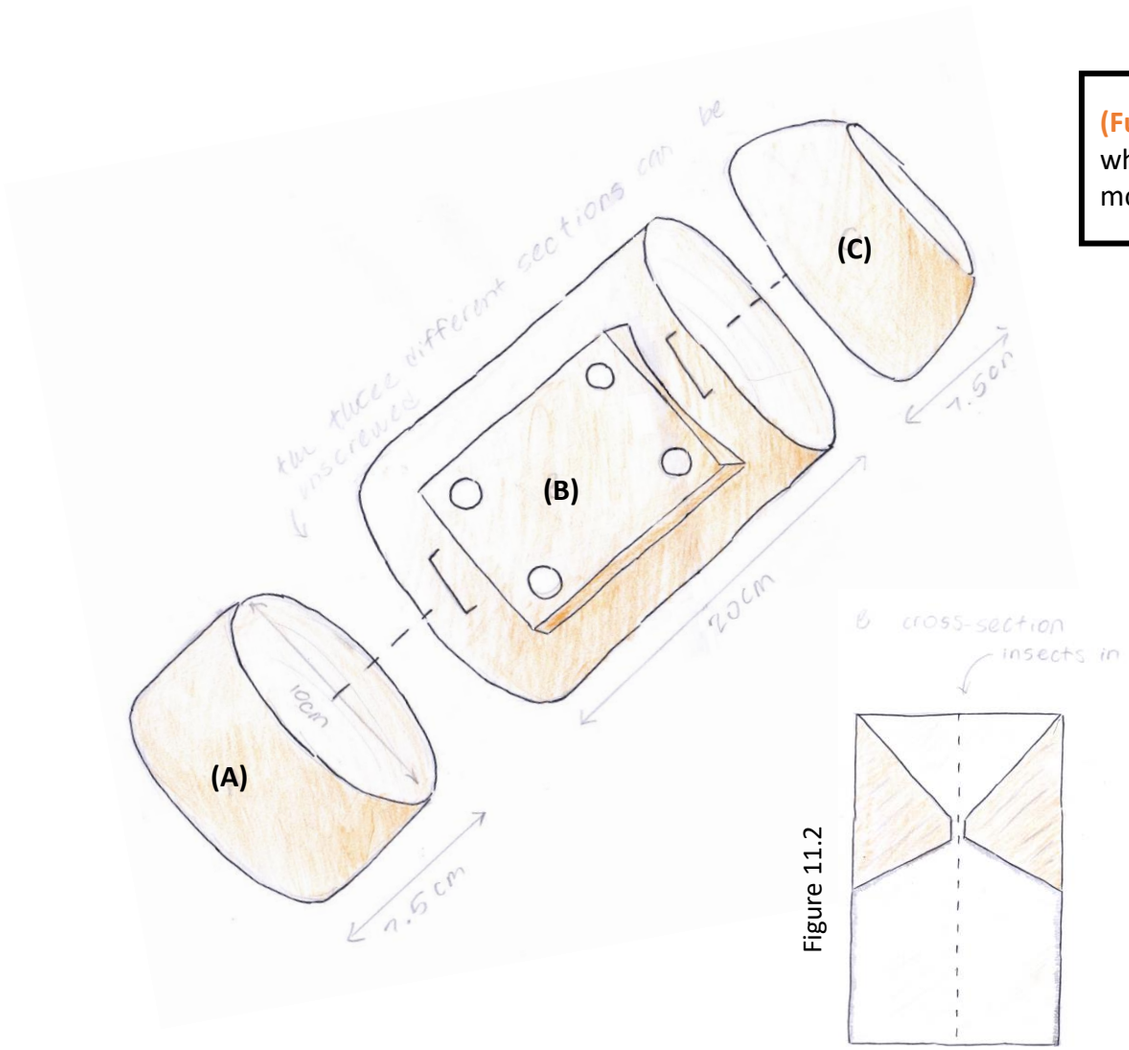


Figure 11.2

(Functional Explanation)
To use the mosquito trap:

(1) Fill section A with water
(2) Screw A onto B, remove C
(3) Leave for a few days, to allow mosquitos in
(4) Close Cap C, and allow mosquitos to perish
(5) Mosquitos have perished, open A and empty out remaining contents, and refill with water
(6) Repeat

(Functional Explanation) The prototype works by luring in mosquitos into the section B where once they have entered, they are unable to leave thus meaning the entering mosquitos are trapped and are killed.

(Materials and Components) Section (A) is where water is filled up to attract mosquitos and is unscrewed to remove perished insects easily and quickly without further spreading decease.

(Materials and Components) The device will be injection molded to allow mass production so it can be placed in any locations and areas in the world.

(User Requirements) The holes on section B allow the prototype to be mounted on a wall or a tree.

(User Requirements) The prototype also contains mounting holes to allow it to be bolted to a tree or a wall, and contains mountings slots to allow it to be hung on trees, etc.

(Performance Requirements) Since the design will be bolted to a tree it will be exposed to multiple hours of sunlight throughout the day, rain, and heat. This means the plastic should be hardwearing and able to handle high temperatures and not become damaged and brittle in the sun. A suitable material would be HDPE. HDPE is quite sustainable as this is because it is a relatively common plastic and is a relatively rudimentary plastic and so it is quite easy to recycle.

(Cost) HDPE, since rudimentary and common is quite cheap keeping the costs down for this device. Moreover if the pieces are injection molded it would be highly efficient and not a lot of resources or energy will be wasted whilst keeping costs down due to economies of scale.

(Materials and Components) Roughed surfaces with small spikes so mosquitos cannot land, meaning the must have to land on the water to rest increasing the chances of them drowning, and perishing.

(Materials and Components) The mechanism shown in figure 11.2 allows mosquitos in easily but makes it impossible for mosquitos to escape. This done by having a very small hole that is near steep places so that the mosquitos cannot land there and thus do not land nearby the exit, thus reducing the chances of escape.

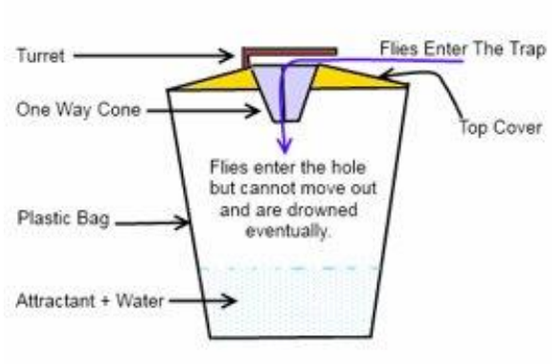


Figure 11.1

(Inspiration) Figure 11.1 depicts a do it yourself plan for a mosquito catcher, I have used this as my inspiration as it provides a good working principle which can be built upon with my design.

(26) Initial Design Ideas (Water Purification Device)

(Functional Explanation) The prototype acts as a sort of straw or filter which is able to purify dirty water making it safe for drinking.

Figure 12.1

(Functional Explanation) Attach the pipe from the input value from the pump to the output of the filter, and then place the output of the pump over a bucket or tub where the filter water can be collected. The filter works by forcing the water through progressively smaller and smaller filters which will progressively filter out dirt, dust, sand, bacteria, viruses etc.

Each filter contains four different pods which will be used to filter out a certain and specific contaminant.

(Inspiration) Figure 12.1 shows a bicycle pump's foot rest where a foot can be placed onto the metal piece this stabilizing the pump and allowing more power to be inputted into the pump for more air volume.

I have adapted this design into my filter design so that it is able to

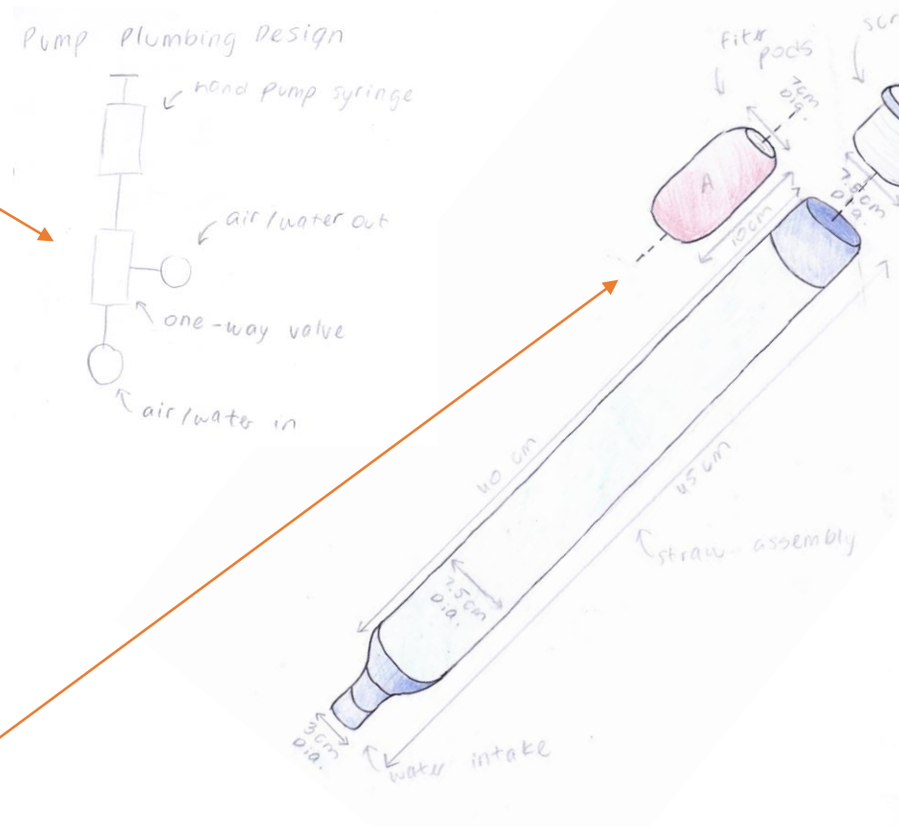
(Materials and Components) The pump here is almost like a bicycle pump but has a one-way valve to prevent any water from flowing into the pump piston. The working principle behind it is shown on the right.

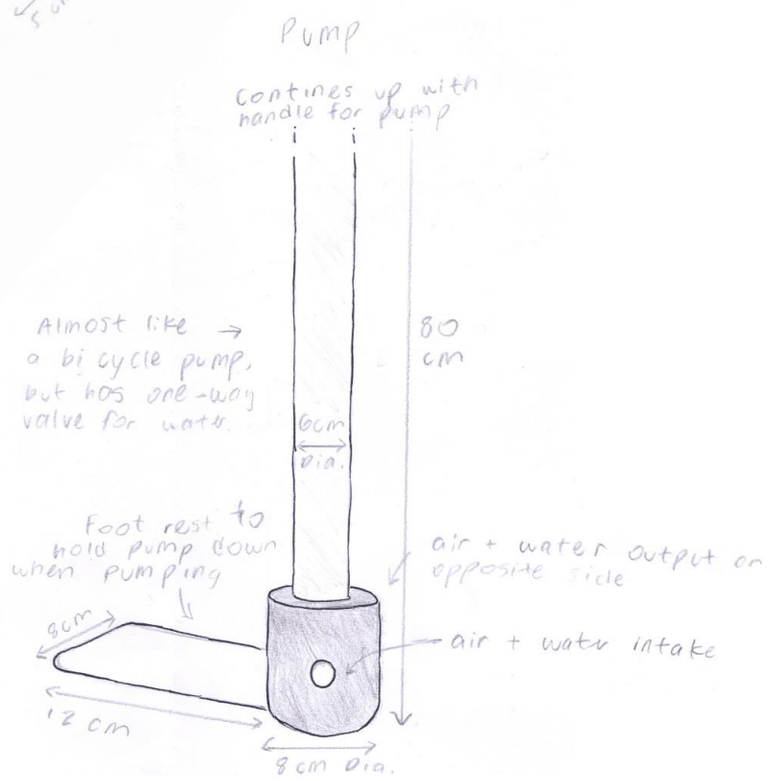
(User Requirements) Footrest to hold the pump down when pumping. Thus improving the ergonomics of the design.

(Materials and Components) The pump and straw are able to attach together using snap fit fittings and are able to be carried around as one package, this will be done through the use of press fittings that the pump can snap to.

(Materials and Components) Four of these pods are inside the straw, and each section is able to filter out a certain contaminant, the filters need to modular this way as it will reduce waste as the straws will not have to be thrown out and also different filters.

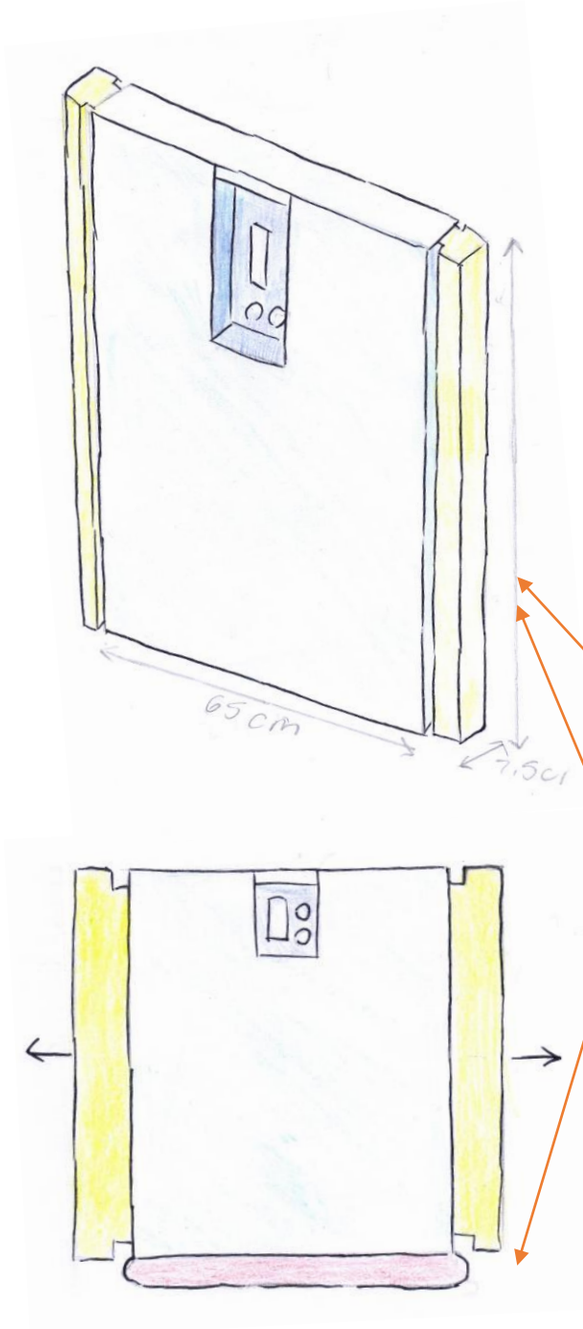
Moreover this system will allow the straw to be adapted to different regions where ex. Heavy metal filter, or extremely fine virus filters may be needed.



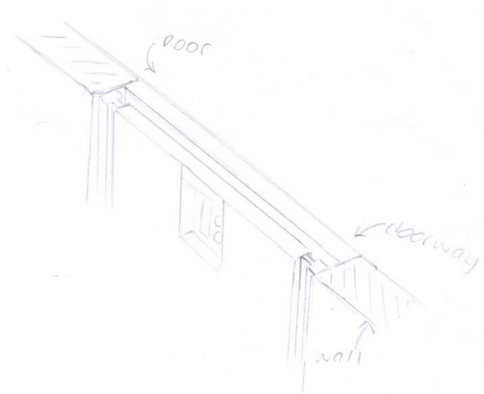


(Performance Requirements) The filter may be exposed to many chemicals and containments and so the plastic that the casing is made out of should be inert and thus handle such materials without degrading.

(27) Initial Design Ideas (Flood Barrier)



(Functional Explanation) This prototype is a door / window / garage sealer that if flood water is expected, it can be placed in a opening to the house and using a wrench the device can be expanded to shrunk to fit any doorway possible, it also has a balloon on the bottom to help seal the bottom properly too thus creating a sort of barrier for the flood water and thus protecting the house from water damage.



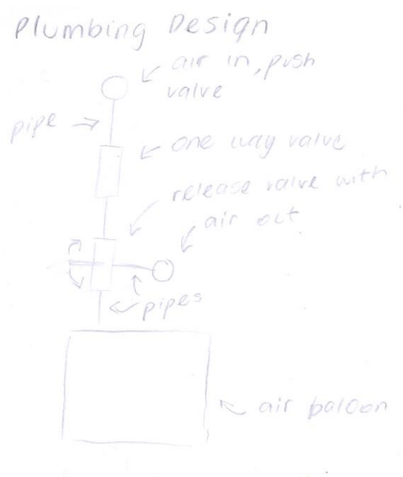
(Functional Explanation)
To use the flood barrier:

(1) Place the flood barrier in a open you want blocked
(2) Use a socket wrench to move the slides in or out, this will allow you to adjust to the doorway's width
(3) Once the barrier has been tightly fitted to the door use a hand pump to fill up the balloon with air to seal the bottom of the opening

(Materials and Components) The device contains slides that are able to be slid out and retracted to span almost any size of opening. However if the opening is too large two flood barriers can also be used in parallel to increase the size of the span. The barriers are able to latch into each other, and thus meaning hug spans can be covered, or even flood walls can be created.

(Performance Requirements) (Materials and Components) (Cost) The prototype will be exposed to huge pressure forces from the water, and so firstly the rubber grommets on each side of the side's should be made of a very 'sticky' and tough rubber that will not slip, the same goes for the balloon. Moreover the plastic should be reinforced with steel ribbing or the casing of this device should be bade form metal and steel ribs must be placed instead for added strength, the device should not be solid metal as it would be too heavy and costly and a wastage but steel ribbing may be a good compromise between strength and cost.

(Materials and Components) The plumbing for this device is shown on the right, the plumbing here has been designed too be able to handle high pressure and if a certain pressure is exceed the release valve will automatically vent the air out as a failsafe



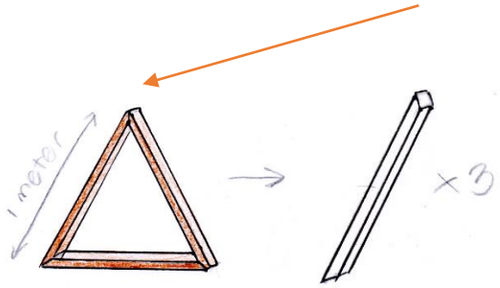
(28) Initial Design Ideas (Shelter)

(Functional Explanation) This prototype contains modular triangular pieces than can be connected together to form large structures that can form disaster camps where government services can deploy these triangles quickly to form buildings in the immediate area of the disaster providing much need to those stranded are in danger because of a natural disaster, or adverse weather due to climate change.

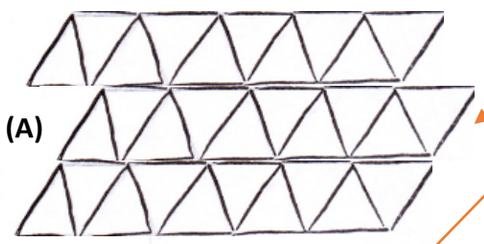
(User Requirements) (Materials and Components) To make the triangular pieces easy to move around and deployable they are firstly made of plastic to keep the lightweight for their large size, and so they do not need any machinery to deploy.

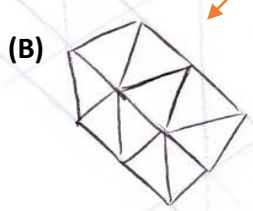
(Performance Requirements) (Sustainability) The product will be exposed daily to huge temperature swings, and will be exposed to direct sunlight for hours on end, this means that the injection molding beams need to be made of plastic that is able to withstand such conditions. A prime example would be HDPE. HDPE is quite sustainable as this is because it is a relatively common plastic and is a relatively rudimentary plastic and so it is quite easy to recycle.

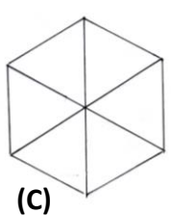
(Materials and components) The design consists of a clear or colored plastic insert, and injection molded HDPE pieces that form the structure.

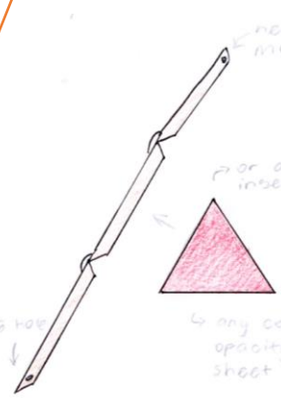


(User Requirements) The device can form almost any structure possible (but not too large due to large overhangs, this means they can form walls (A), angles (B), and circles (C).

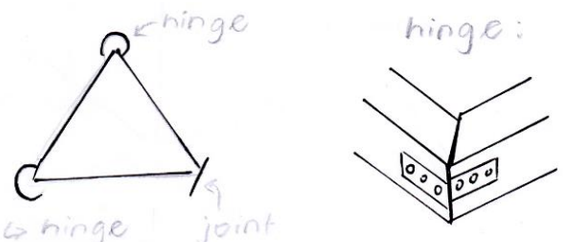




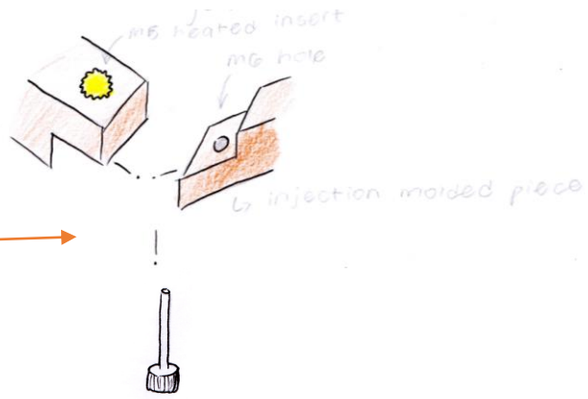


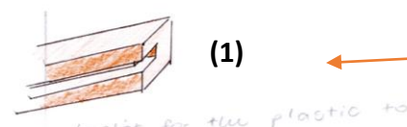


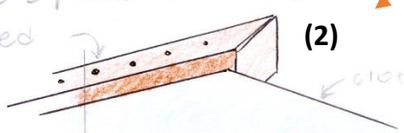
(Cost) HDPE, since rudimentary and common is quite cheap keeping the costs down for this device. Moreover if the pieces are injection molded it would be highly efficient and not a lot of resources or energy will be wasted whilst keeping costs down due to economies of scale.



(User Requirements) To aid the quick assembly process there are two hinges, and only one bolt per triangular piece. The colored insert then slides into the piece so that it gets locked into the triangle.







(User Requirements) The colored insert can either be a plastic insert (1), or a cloth insert which is pre-stretched over the joints (2)

(Inspiration) Figure 13.1 shows interconnected LED panels that are used to decorate rooms, this originally had given me the idea about modular panels that may be used to help those with neurodiversity all the way back in the investigation section.

However, modular panels such as these (at a large scale) could be used to erect temporary hospitals, shelters, warehouses, etc. for refugees of climate change or refugees as a whole.

Figure 13.1

(29) Initial Design Review (Grading Table)

		Design Name					
Area	**Spec. Point.**	**Water Catcher**	**Hexagonal Float**	**Mosquito Trap**	**Water Purification Device**	**Flood Barrier**	**Shelter**
Form	1.1						
	1.2						
	1.3						
Function	2.1						
	2.2						
	2.3 (max 5)	5/5	4/5	2/5	5/5	2/5	3/5
	2.4 (max 5)	5/5	5/5	1/5	3/5	0/5	3/5
User requirements	3.1						
	3.2						
	3.3						
	3.4						
	3.5						
Performance requirements	4.1						
	4.2						
	4.3						
Material and components	5.1						
	5.2						
	5.3						
Scale of production and Cost	6.1	0	0	0	0	0	0
	6.2	0	0	0	0	0	0
	6.3						
Sustainability	7.1						
	7.2						
	7.3						
	7.4						
Total (yellow)	---	10/10	9/10	3/10	8/10	2/10	6/10
Total (others)	---	15/18	15/18	15/18	15/18	10/18	16/18
Grand Total	---	25/28	24/28	18/28	22/28	12/28	22/28

Introduction:
In this section, I plan to grade each of the designs using a table to gauge whether the product is successful or not.

**The light blue at 2.2 means that it is not a compulsory spec point (as the spec point says 'could', it still has a color to indicate whether it has been done or not. (2.2 is still considered in the total count though)*

**The yellow at 2.3 and 2.4 indicates that these two spec points have a large weight In the final count as the each are worth a maximum of 5 points. This is done to judge the overall effectiveness of a product's ability to help those in need, as in the end the product that helps those in need the most should be produced whilst not compromising in the design that much.*

So basically, we want a design that has a balanced score between Total (yellow) and total (others), this will suggest that the product will have the highest positive influence in the world and will also still be a good design so that it is not wasteful and long lasting.

** The dark blue at 3.2, 3.3, and 3.5 are specification points that we are unable to judge at the moment as the product is just in the design stage and is not a final, and not a final product. So thus, a final manual has not been created for it and thus these points cannot be graded.*

** The light blue at 6.1 and 6.2 means that it is not a compulsory spec point (as the spec point says 'could' and so is thus not considered in the final count, it has no color as it is not fair for scale of production to determine the success of the design as these two spec points do not really affect the final effectiveness of the design*

**Red means the design has scored nothing in that specification point.*

**Green means the design has scored one point in that specification point.*

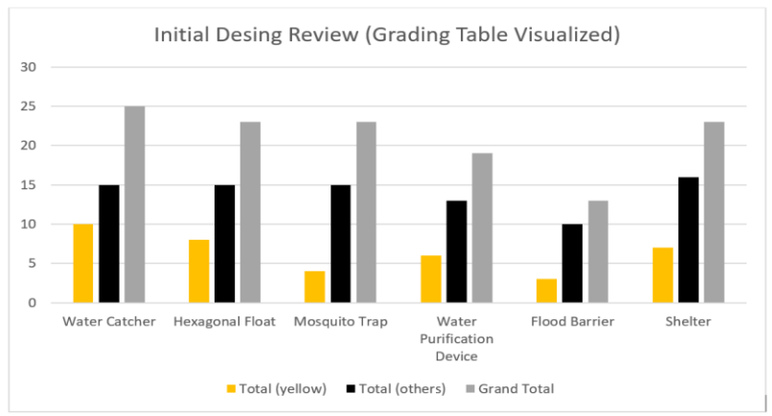


Figure 12.1 shows a bar chart that has visualized the data on the graph. We can see that overall, the water catcher scored the highest in the yellow section and in the grand total section, whilst the shelter has scored the highest in the other sections. Thus, meaning that the water catcher will have the highest impact, but the shelter has the best design. We can also see that the shelter, the catcher, and the float have the best balance (as the have high impact and have good designs) and so are considered to be the best designs out of the six as stated above. The barrier is by far the worst design of the six and should not be considered as a final product without extensive development. Lastly, although the mosquito trap and the water purification device have a good design, they do not have a large impact in the world compared to the other two designs.

(30) Initial Design Review (Grading Table) (Continued)

		Design Name					
Area	Spec. Point.	Water Catcher	Hexagonal Float	Mosquito Trap	Water Purification Device	Flood Barrier	Shelter
Function	2.3 (max 5)	5/5	4/5	2/5	5/5	2/5	3/5
	2.4 (max 5)	5/5	5/5	1/5	3/5	0/5	3/5
Total (yellow)	---	10/10	9/10	3/10	8/10	2/10	6/10

Conclusion:
After completing this section, I have identified the water catcher as the most successful design out of the 6 designs. I have also mentioned how I gauged the success of each design and have also talked about why each design scored what it scored in the yellow section. I have also used a graph to visualize the results. Lastly, I have identified the water catcher, the float, and the shelter as three designs that ultimately, one should be chosen from as they look the most promising.

Moving Forward:
In the next section, I plan to write 6 overall conclusions on each design after completing a detailed analysis on the strengths, weaknesses, and areas of development for each design. This will help me decide whether the three designs mention above are as promising as they seem here, and whether which of the six in total should be taken forward for peer + client + user feedback and ultimately development.

2.3a It must provide relief or support the chosen demographic from climate change.

Water Catcher:
This design has scored a 5/5, and also has the highest total (yellow) score. This is because the design addresses a very common need in any civilization, clean water for drinking cleaning cooking, agriculture, etc. Many regions in the world are facing drought and thus have to move to newer locations with a more plentiful supply. This is especially true if rainwater or rivers are the major source of water for communities as they are the most susceptible to drought. Without water a community will have none for cooking and drinking, and just as importantly none for growing crops which are is one of the major necessities of a community. This problem directly helps those vulnerable to climate change, as climate change causes desertification, and prolonged drought.

Hexagonal Float:
This design has scored a 4/5, as it addresses a major need in any civilization, food. A community's major lifeline is their crops, this is especially true in the developing fund where this is no national emergency grain / cereal store when farmer's crops are destroyed due to climate change. This can result in the starvation of entire communities. Flooding is something that threatens food safety greatly as it can destroyed huge areas of crop land in days, hence why this product has a very large impact as it can prevent an immeasurable amount of suffering which would otherwise happen due to the effects of climate change. The product has not scored a perfect 5/5 as there are other consequences of climate change that need addressing more than this, namely flooding and drought.

Mosquito Trap:
This design has scored a 2/5 in this section as for this product to effective it would have to deployed in large numbers which would make it very costly. Also, since it is a more passive system the number of mosquitos caught will not be large and thus as said before it will need to deployed in large numbered to make any tangible change in mosquito numbers in a local area. Also, since the trap is relatively small it will have to be cleaned out regularly also increasing costs and making the design cumbersome. Perhaps, if the product was deployed in homes, it would have a small benefit. Although, this design still helps those vulnerable due to climate change as rising pest numbers are a consequence of climate change, as regions previously considered too hot or cold for mosquitos have become temperate enough for them to live, but overall, the impact of the product is low (and the product will have to developed greatly which will require great efforts to make it feasible) compared to the other designs and should only be considered once the other designs have been extensively developed.

Water Purification Device:
This has scored a 5/5 as again the design addresses a very common need in any civilization, clean water, for drinking cleaning cooking, agriculture, etc. Many regions in the world do not have clean water, and as a result of this very large numbers of deaths occur due to water borne deceases, or due to chemically polluted water. This product has a very large possible impact if developed correctly and can change the lives of many positively. If executed well it can pave a path to eradicating deaths due to such reasons. This also helps those vulnerable to climate change as rising sea levels can pollute ground water and rivers.

Flood Barrier:
Although flooding is a very huge problem nowadays, this product's main usage is to bar doors in homes to prevent them from getting flooded with possibly polluted war thus reduces the chances of get sick in the household, and also saving the house in the process, this results in a very low impact as the main consequence of major flooding is destroyed crops which threaten many communities, and this is better addressed by the hexagonal float. Hence why this design has scored a 2/5. This design helps those who are vulnerable from climate change as flooding is a consequence of climate change.

Shelter:
This design has scored a 3/5 as although it has a very large impact to those effected by tropical storms, especially those that are freak storms, on the whole it is unable to have a large impact as, the numbers of those effected by freak storms are relatively low compared to those effected by drought, rising sea levels, disease. This product has not scored extremely low though, as it still helps those vulnerable to climate change by providing a temporary shelter when a freak storm has displaced them. The design should still be considered as it could still have a positive impact in the world.

2.4a It should act as innovative product to promote sustainable lifestyle among the community.

Water Catcher:
Since water is an integral part of a community, this has scored a very high here (5/5), firstly it is directly helping members of the community so it will be appreciated greatly. And secondly it provides a basic need, it also removes the need for walking great distances to obtain water. School children can also be taught the effects of climate change the importance of being sustainable, as the water catcher will be a tangible 'monument' to this.

Hexagonal Float:
The same said above is true here, as farmer's fields will be protected, and these fields are also an integral part of the community. Hence, why this design has scored a 5/5 in this section.

Mosquito Trap:
This design has scored a 1/5 in this sections, as firstly it has scored a low score in the previous section as it does not have a large impact. The same is here as if the design does not have a large impact, then those around it will be unable to see the real benefit and it will not encourage a more sustainable lifestyle to mitigate the effects of climate change.

Water Purification Device:
This product has scored a 5/5 as again water is an integral part of a community. The reasons mention in the water catcher are applicable here too.

Flood Barrier:
Since this is a more temporary solution to flooding, when a flood is not in progress, then the flood barrier will most likely just be packed away. This means that it will only temporarily remind the user that the barrier is required as climate change is happening.

Shelter:
This has scored a 3/5 as although it directly remind the user's that they need this shelter due to climate change as they have been directly displaced by it, it again, is a temporary solution and may not completely remind the user to be more sustainable.

(31) Initial Design Review (Strengths, Weaknesses, Areas to Develop Table)

Introduction:
In this section, plan identify the strengths, weaknesses, and area to develop in each of the designs from the initial review. I also plan to make a final overarching conclusion on each of the designs will decide which of the 6 I will take forward for feedback and then ultimately one of the three to take forward into development.

Design Name	Strengths	Weaknesses	Areas to Develop
Water Catcher	The design is modular and adaptable meaning it's capacity can be increased as needed, or as the community grows. No concrete must be poured for the foundation of the catcher meaning costs are reduced. No specialist tools are required as mostly everything uses hooks, the only location where tools will be requires is bolting the horizontal support bars to the vertical aluminium beams. The catching net itself is made of inexpensive and standardized fishing nets, thus reducing costs. The design uses materials that are long lasting and so the device will not need repairs reducing costs and raising service life.	(1) The red plastic catcher is rather cumbersome and when assembled it will have leaks as the catcher is designed to fold so that it takes up less space during transport (2) The design is not intuitive to use and will require prior knowledge to operate. (3) Throughout the year the direction and abundance of low-lying cloud cover changes and so the catcher may need to be moved, this is a problem as the catcher is very firmly mounted to the ground. (4) The design may weigh more than 20kg making to very difficult to carry to remote locations. This cannot be known for certain as the design has not been developed, but anyways reducing the weight of the design will be beneficial as it will reduce carbon footprint and make it easier to carry. (5) The design is an eyesore; it should have more muted colours that do not stick out and blend in into the environment.	(1) Change the water catcher design. Perhaps using a PVC pipe on the bottom of the net to funnel the water straight into a pipe will be better. (2) Change the design or include extra information to make the design more intuitive to use. Perhaps including an additional user manual on top of the instruction and climate change booklet may be beneficial. Also adding labels to the product, itself may help aid assembly. (3) Find a compromise between stability and movement for the design as during the year it may need to be moved. (4) Reduce weight of the design. (5) Aesthetics of the design and make it compliment the local environment.
Hexagonal Float	The design is adaptable as different floats can be connected to form one 'super float' which can change shape and size to take into account the number of crops needed and the shape of the land. The float is complimentary to the environment and uses muted colours which do not stand out too much in farmland. The design has ergonomic grips which make the float easier to carry around and thus make it less tiring to carry to remote farmland.	(1) The design is not intuitive to use and will require prior knowledge to operate. (2) The design is unnecessarily complex, especially how the plastic sheet with hols slots into the frame. (3) The way the float breaks away from the ground when there is flood water and breaks the roots is inefficient as it can stunt the growth of the plants or kill them. Also, if the buoyancy force is not strong enough to counteract the strength of the roots the float will stay under water and the plants will drown. (4) The shape of the floats should be altered to reduce the height of the float so that farmland does not have to be completely changed to accommodate the floats.	(1) Change the design or include extra information to make the design more intuitive to use. Perhaps including an additional user manual on top of the instruction and climate change booklet may be beneficial. Also adding labels to the product, itself may help aid assembly. (2) Find a compromise between strength and complexity for the joints and overall design. (3) Overhaul how plants are held in the float, perhaps include a compartment that holds the soil and roots, and holes on the top and bottom faces of the compartment to allow plants to grow on top, and extra water to drain through the bottom, thus preventing the plants from drowning when being watered. (4) Find a compromise between buoyancy and height so that farmland is not severely altered.
Mosquito Trap	The design is semi adaptable as since the different sections can screw apart larger and smaller compartments can be screwed into place. The design contains many different mounting holes and such which allow the design to be mounted in different places increase the trap's effectiveness.	(1) The design is an eyesore; it should have more muted colours that do not stick out and blend in into the environment. But the design should not be completely invisible as it needs to be found easily, so perhaps keeping it the same way it is in bright colours may be beneficial. (2) The trap uses permanent joinery methods meaning it will be difficult to recycle and to disassemble when repairs are needed. (3) The materials used here are not long lasting and will easily deteriorate in the weather especially in hotter environments. (4) Mosquitos may not easily be attracted into the trap. (5) The size of the trap may need to be altered to reduce the times it needs to be emptied.	(1) Experiment between visibility and muted colours. Find a compromise. (2) Find a compromise between simplicity and recyclability. (3) Experiment between different materials and find a compromise and durability. (4) Experiment between different methods of attracting the mosquitos need to be experimented with, for example different colours, chemicals, smells (5) Find a compromise between size, cost, and capacity.

(32) Initial Design Review (Strengths, Weaknesses, Areas to Develop Table) (Continued)

Design Name	Strengths	Weaknesses	Areas to Develop
Water Purification Device	The design is modular as different types of filters can be installed to filter out different contaminants in different regions. This increases the maximum reach of the product.	(1) The design contains non-standardized filter 'pods' which severely raise the cost of the design and make it less environmentally friendly as the pods are thrown out once exhausted. They also have a large carbon footprint as they will need to be shipped to remote parts of the world and reduce the product's effectiveness. (2) The filter uses permanent joinery methods meaning it will be difficult to recycle and to disassemble when repairs are needed.	(1) Experiment with standardized filters or find a way to allow the user to make their own makeshift filter when none are available. (2) Make the different sections screw caps so that they can split into different parts, this will make it easier to clean out the filter if blocked, and to repair it if damaged. Find a compromise between costs and recyclability.
Flood Barrier	The design can be quickly deployed and is quite simple to setup on doors, and windows.	(1) The design uses a ring spanner to deploy which may not be available everywhere, making it impossible to deploy without such a tool. (2) Perhaps make the design modular to allow it to be adapted to different door sizes and to be able to span larger gaps such as garage doors and low-lying windows. (3) The design is made of mostly plastics which may buckle under the extreme loads of heavy water or a flash flood. Also, the air bag underneath is made of a very fragile rubber which can easily be pierced.	(1) Perhaps change the deployment mechanism to have a gear ratio so less force is needed to open the slides more slowly, so that it can be opened by hand. Or make a ring spanner come with the product. (2) Alter the way the design latches onto other parts so that the design is modular / adaptable. (3) Use a stronger materials that is not able bend easily and that is able to keep its shape under high loads
Shelter	The design is low cost and can shield the user from the semi low temperatures such as of that in tropic storms where heavy rain and semi-high winds are common. It can also be deployed in	(1) The design is susceptible to tearing due to sharp objects hitting it, this is due to the plastic canvas structure acting as the main body. (2) The plastic canvas is also highly polluting as since it is plastic and is quite fragile it can easily be ripped and is thus quite quickly replaced. This is not a major issue as these are temporary shelters only designed to last a few weeks. (3) If temperatures drop too low fires may need to be started inside the tent to provide warmth, this is problematic as the tent canvas will melt and may catch on fire.	(1-3) Find a suitable canvas that is lightweight, non-polluting, does not melt easy / is fire retardant, and does not tear easily. A good balance of all three properties must be found to ensure optimum material properties and cost.

Conclusions:

Water Catcher:
This design should be considered for development as it has a very high total (yellow) score meaning it has a large impact, it also has a relatively good design, but there are many improvements that could be made.

Hexagonal Float:
This design should be considered for development as it has a very high total (yellow) score meaning it has a large impact, a major issue with this design is that it is too complex, and rather than tearing the plant's roots it should just carry the plants on top of the water, this means a large amount of development will be needed.

Mosquito Trap:
This has many major issues with it, it also has a low impact and so should not be considered for further development.

Water Purification Device:
This device although having a high impact has multiple issues and would take large amounts of time to develop. It should still be considered but there are better options such as the shelter, the water catcher, and the hexagonal float.

Flood Barrier:
This design should not be considered for further development as firstly it has a low impact, and secondly it has many major issues which will need to be addressed during development.

Shelter:
This design should be considered for development as it has a good design and also has a relatively high impact.

***Overall**, the water catcher, hexagonal float, and the shelter should be taken forward, the water purification device (in yellow) should still be considered for feedback, but ultimately it is unlikely it will go forward through to development. It is most likely one of the three in green will go forward. The designs in red should not be considered as they have multiple issues, and do not have as big of as impact as other designs.*

Design Decision:
I have decided to take the water catcher into the next phase of the initial design review, as after identifying the strengths, weaknesses, and especially the areas to develop of each design I have decided that the water catcher has the largest chance of having a large impact on the world as water scarcity is a rising issue especially due to the rampant climate change present nowadays.

Conclusion:
After completing this section, I now know that the three strongest designs are the water catcher, the hexagonal float, and the shelter. I now know what will need to be developed and tested when the product is in the development stage.

Moving Forward:
In the next section, I plan to ask for client/user, and peer feedback on the water catcher. I will not do all six or the three strongest so that I am able to go into more depth into the water catcher design design and am able to get more accurate and effective feedback that I will then be able to apply to my chosen design in the development stage.

(33) Initial Design Review (Peer and User/Client feedback)

Introduction:
In this section of the initial design review I plan to ask my peers about how my chosen water catcher design can be improved, and also ask my user/client what further needs and wants they would like addressed in the final water catcher design.

User/Peer Feedback

"Perhaps include a filter to make sure that water is 100% safe to drink"

"How exactly will the net attach to the frame?"

"What type of joinery will be used in the frame? I also believe that welding may not be suitable as it is permanent and perhaps the device may need to be disassembled later"

"At the moment the design is quite ugly looking, and may be an eyesore, perhaps using more muted colours that complement the local environment may be beneficial to reduce visual clutter."

"Perhaps making the design modular may be beneficial to improve it's capacity and thus allow the design to be adapted to the community it is deployed into."

"Our workshop may not have any aluminium available and we may not be able to machine, cut, or weld it. A different material type for the frame may need to be considered."

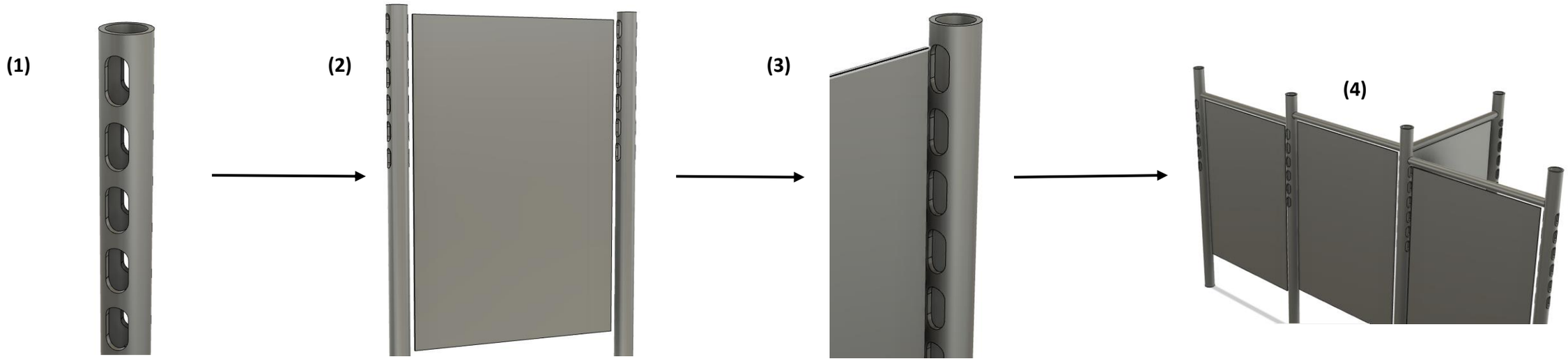
"Perhaps including a visual and language friendly assembly booklet ay be beneficial to the design as it may aid user's in assembling the final prototype, and will also provide a manual for potential repairs."

Conclusion:
After completing this final section of the initial design review I have been able to gain valuable feedback from my peers on areas that could be developed and improved to make the final water catcher design a success. Moreover I have also gained feedback from my user/client which will again allow me to address and lacking areas in the design right so that the final design is successful as possible.

Moving Forward:
In the next section of the NEA, I plan to start the development section that will address said feedback, I will firstly start with some brainstorming frame ideas as the current initial ideas water catcher frame I still missing some sections of its design, and perhaps a new design may be beneficial.

(34) Development (Frame Rev. 1)

Introduction:
In this section of the NEA, I plan to develop areas of the water catcher design that have been highlighted by peer and user/client review. This in turn will allow me to have a more streamlined final design process and thus the chance of success of the final prototype is increased. The development section is split into multiple sections and each section focuses on a certain aspect that needs improving or exploring, each page has a summary detailing what has been found.



(1) Vertical Posts:
I have modeled in slots into the posts to firstly reduce the weight of the post, and then secondly to allow a mounting point for the net. Zip ties could be used to connect the net to the vertical posts and thus provide a simple yet effective way of mounting the net.

The post will be sunk into the ground and can easily be inserted into the ground as it is hollow, this means it can be hammered into the ground using mallets of the ground is soft enough , or else a small hole can be dug and then the post placed into the hole and then the hole gets backfilled and then packed with more earth.

(2) Horizontal bars:
Here I have modeled in both posts, and have also modeled in a simple plane for the mesh.

I have also begun brainstorming ideas of a horizontal bar to support the net and to provide strength to the water catcher, I will later explore the horizontal bar in the next section of the development section, and the new mounting in a future page.

(3) Net mounting system:
Here I am brainstorming ideas for the net mounting system, perhaps instead of using zipties, a slot can be cut into the length of the aluminum and a cloth attached on two smaller aluminum bars can be slid into the larger vertical support and the cloth is passed through the slot to provide tension.

Retrospectively, this is net mount type 3.

(4) Water catcher modularity:
To directly address the assigned design specification point 2.2, and the peer and user/client feedback I have decided that a main advantage of this prototype is that it is modular and adaptable and thus expandable to meet the needs of any type of regions, community, weather types, seasons etc.

Here I am experimenting with multiple nets at different rotations, multiple rotations will allow communities to make vast arrays of such water catcher that are able to curve with the landscape, and thus form large ‘water farms

Summary:
After completing this section of the of the development phase I have a rough idea of areas to continue to develop in the coming section, I will come back in revision two to further develop the frame. I plan to develop this rough design further in revision 2, and also plan to branch out into more sections of development after exploring the areas of development identified here and in the peer and user/client feedback section of the initial design review.

(35) Development (Frame Rev. 2)

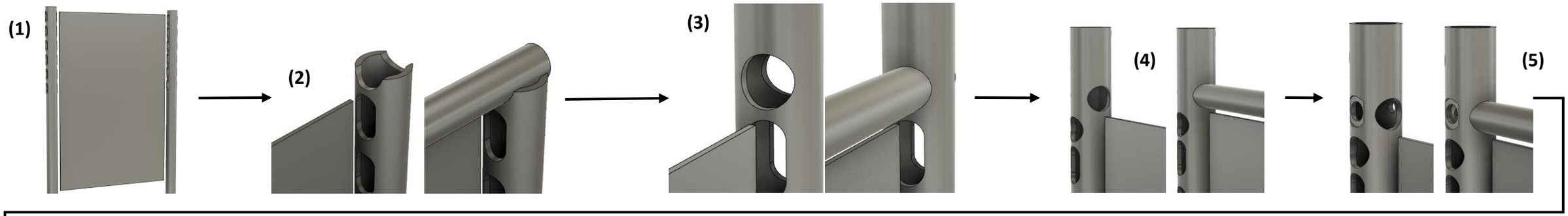
Aluminum Frame Design Iteration:

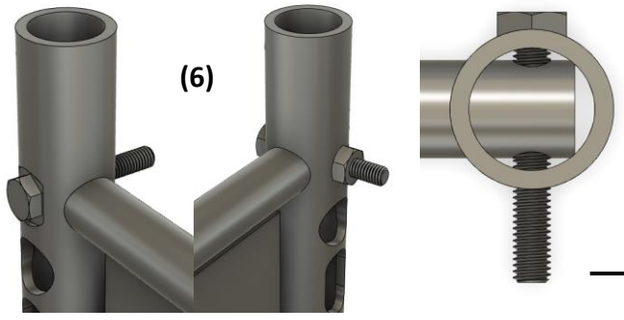
(1) Here I have begun with the same frame from design revision 1. I will develop the horizontal support bars to ensure that the net can easily be mounted.
(2) Here I am trying to mount the horizontal bar on top of the frame, this however is not a good idea as the bar can easily fall off, and here I have though of using zip ties, this however will make the frame very flimsy and very unrigid.
(3) I have opted instead to place the bar into the beam so that it cannot move. The hole here is a through hole and this may not be suitable as the bar is still able to slide out of the frame.
(4) And so I have changed the design once again to make the frame more rigid, I have done this by closing off the hole on the other end and thus making the hole not a through hole. *In retrospect, this is where the idea of the closed and open type vertical support was born.*
(5) I have added holes, and a flattened area for a nut and a bolt to go through. The flattened are is designed in to make the joint more strong, and moreover the nut and bolt is used to increase the rigidity of the design and to prevent the horizontal bar from sliding out.
(6) The nut and bolt has been modeled in here.

Wooden Frame Design Iteration:

(1) Here slots have been cut out for an expected wood joint to be made.
(2) Here I have modeled in the horizontal support bar
(3) And here I have inserted a wooden wedge that will be used to tension the joint and thus prevent slippage of the design thus increasing the rigidity of the design. The wedge will be hammered into the wood piece and this will thus remove the need for permanent wood joinery using glue.
(4) Both sides of the bar have been modeled in.

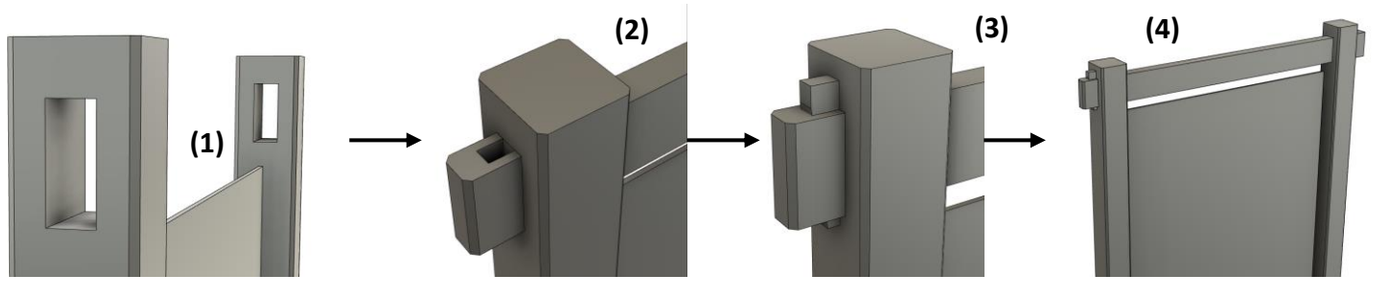
I will ensure to develop this wood joint more in the coming sections to ensure what I have will be a suitable joint.





Wooden and Aluminum Frame Designs:

There are two design phases in this section of the development, one as a continuation of the of the previous aluminum based frame, and one wood type frame as I have come to the realization that we cannot weld, cut, and machine aluminum and so another material has to be considered for the design.



Summary:

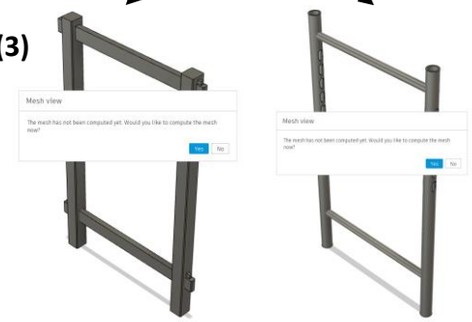
This is the second revision of the previous frame design, here I have further developed the frame design from revision 1, and have also decided to transition over to a wood frame too as I do not have the facilities available to weld, machine, and cut aluminum. After completing this section of the development, I have finalized the two possible frame types I am able to use, this will allow me to choose the better of the two designs in the next page of the development using FEA simulation.

(36) Development (Material Decision + FEA Simulations)

(1)

(2)

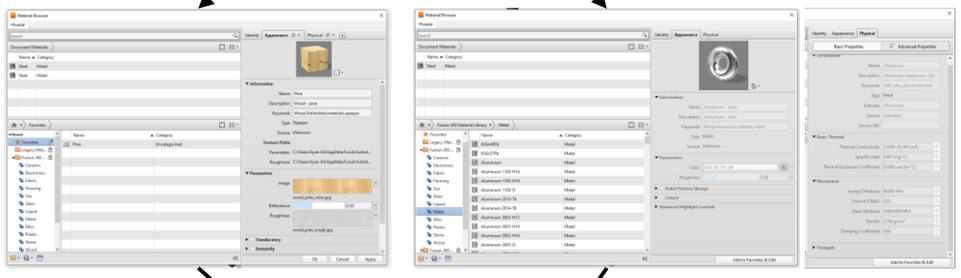
(3)



(4)

(5)

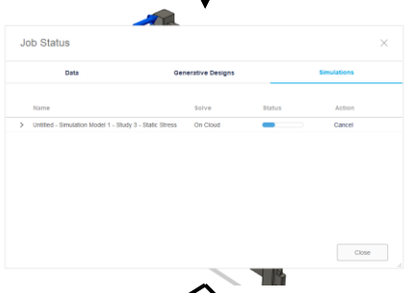
(6)



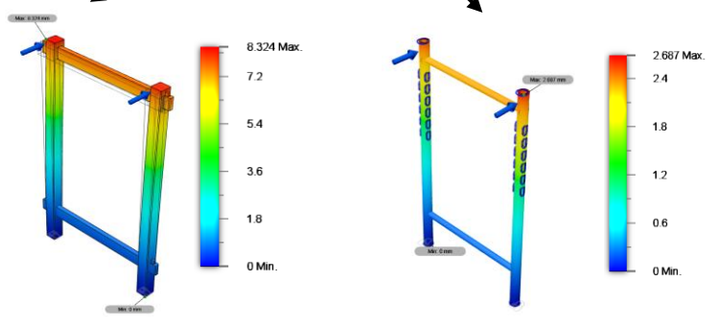
(7)

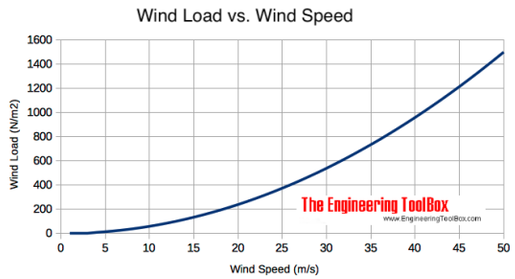
(8)

(9)



(10)





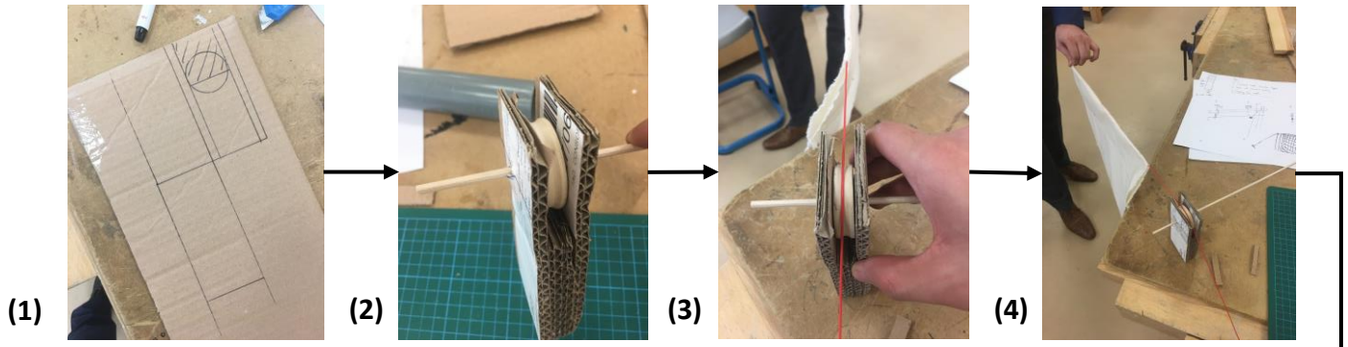
Using this graph I was able to determine the approximate forces applied on the two frames at very high wind speeds, I have also accounted for the lowered drag of the aluminum piece, the winds simulated were at 95 km/h.

Although the aluminum was stronger with a maximum displacement of ~2.7mm (the simulation has been scaled down to reduce simulations times and so 2.7 is not the real displacement). We are unable to weld, shape, bend, drill, and machine aluminum framing and so I will compromise with a wood frame, however I would rather chose aluminum over wood as it has more suitable properties for such a design.

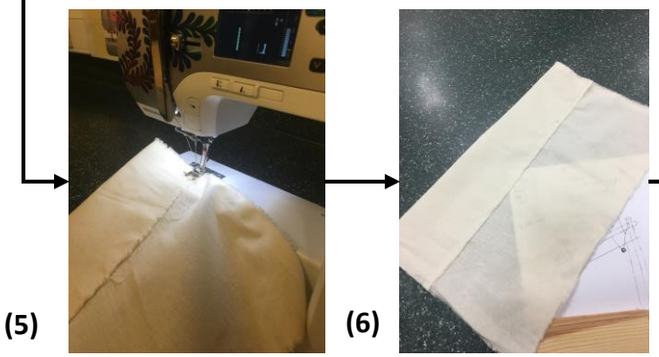
Wood however, is desirable as it can easily blend into the environment thus satisfying the direct peer feedback of the initial design was an eyesore.

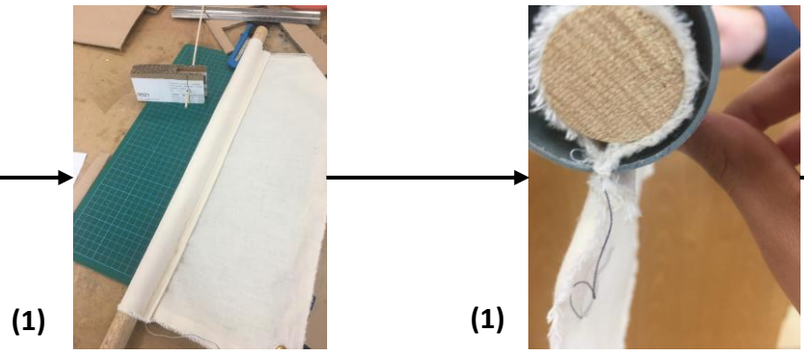
Summary:
After completing this section of the development I have decided to use wood framing instead of aluminum framing as we are unable to machine, weld, and drill into aluminum with the tools available in my school's workshop. However, I will try to compromise using 3D printed plastic joints.

(37) Development (Net mounting)

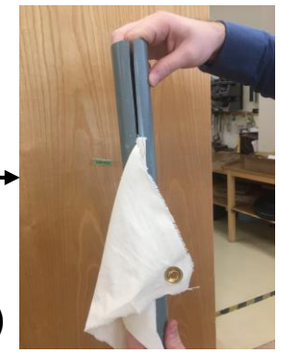


Type 1





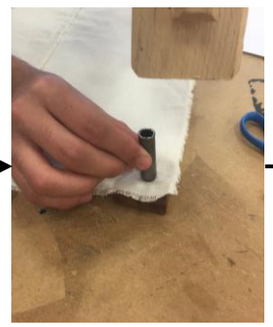
Type 2

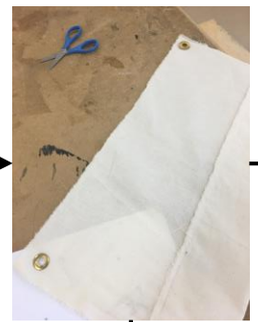


Type 3

Final Net mounting system:
After assessing my findings from the different type nets, I have come up with a completely new design (figure 13.1) that may function better as the net mounting system will act as part of the frame, and will allow adjustability and tensioning of the nets.

The design works by placing the net between wood pieces and then squashing the entire 'wood and net sandwich' together into a solid piece which can act as a sort of frame.





Type 4

Type 5

Type 6

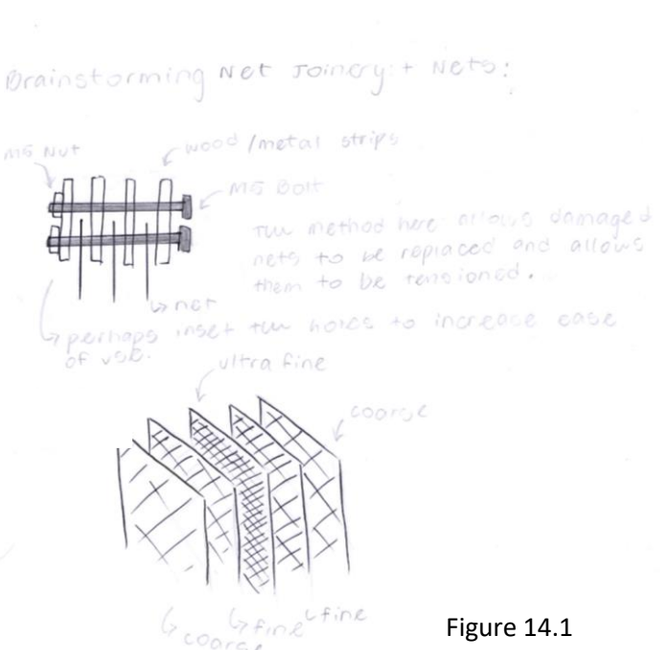


Figure 14.1

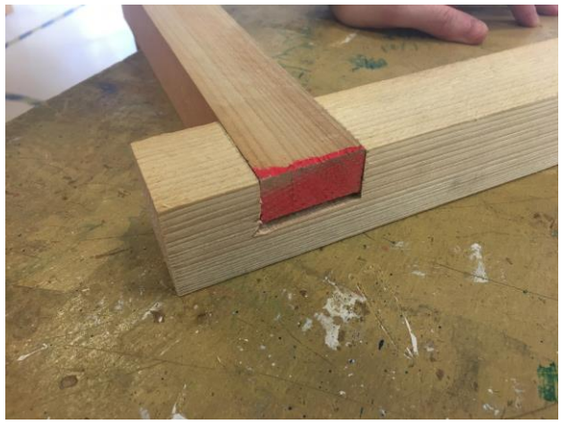
Summary:
After completing this section, I have created six possible net mounting types which will allow me to finalize the net mounting design. These six mounting types have allowed me to brainstorm the final net mounting method, and the result of this has been sketched in a rough draft in figure 13.1. In next section I will figure out how to make this component work with the existing frame from revision 1 and 2 of frame.

(38) Development (Wooden Joinery)

(1) Reverse Mortise and Tenon Joint

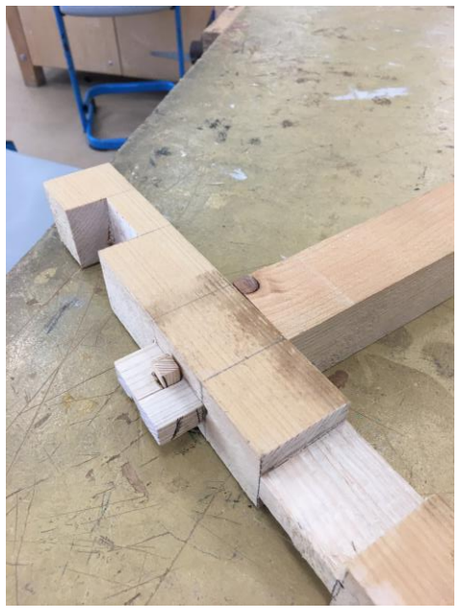
(2) Mortise and Tenon Joint

(3) Half Lap joint



(6) Dado Joint

(4) Mortise and Tenon Modified Joint



(5) Butt Wood Screw joint

Joints analysis:
Here I have made six test joints for wood frame as I have ultimately decided to move forward with a wood frame as an aluminum frame would be difficult to execute.

(1) This joint although strong is not very suitable for the water catcher frame as it is a difficult joint to make and thus would unnecessarily increase the complexity and thus make the final product more costly to produce.

(2) This joint is more suitable as it has similar strength to the previous joint, but is less complex as you would only have to chisel out a hole and the sides, perhaps making this a joint where you do not need to chisel out the sides and only chiseling out the hole is required may be beneficial as this will reduce complexity.

(3) This joint is unsuitable as it is not very secure, and moreover a screw may be required to fasten the wood together basically making this joint similar to joint (5).

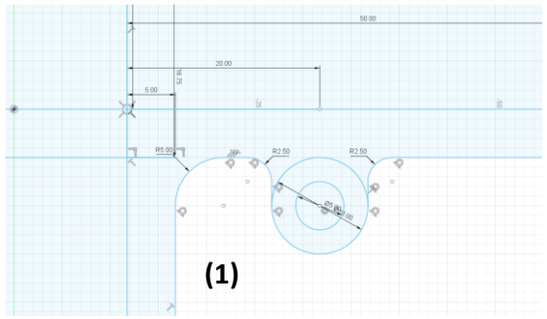
(4) This is an interesting take on joint (2), where we increase the strength of the joint as we are limiting the chance of the wood piece sliding out by having a sort of stopper wedge. This design uses friction to keep the wedge in and so perhaps in dry or in wet conditions in may become lose as the wood may absorb water and thus expand and contract.

(5) This joint is simply a butt joint which has been glued and then screwed together using a wood cut screw, this joint is not suitable as it is not strong enough, and moreover the wood piece may twist if more than one screw is not used. Moreover if the screws are repeatedly removed and installed the wood my split making the frame useless.

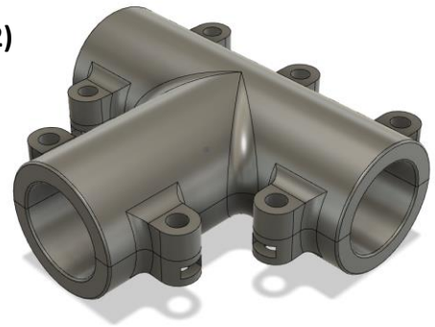
(6) This joint is similar to Join (5) as it uses a wood screw, but the chance of the wood splitting has been reduced as only one screw is required due to the wood not being able to twist. However, this joint is not suitable as it relies too heavily on the screw, and over many fastenings and unfastenings the wood will not be able to hold the thread due to all available wood being pushed away from the screw hole, and so there is no wood grain left for the screw to bit into.

Summary:
After completing this section of the development, I have identified suitable joints, and how they can be developed into a final joint or the finalized wood frame. I have identified wood joint (2) as most suitable as it can be modified to reduce complexity whilst still being very strong and not requiring any permanent joinery methods such as glue. A bolt and nut could also be used to strengthen the join and to improve frame rigidity.

(39) Development (Compromise Aluminum Joinery)



(1)



(2)

Cura Slicer Settings:
195 °C Hotend Temperature
60 °C Build Plate Temperature
95 mm/s Feedrate
0.3 Layer Height
No Supports
Infill at 25% and Cubic
Build Plate Adhesions is Skirt

The parts are printed in PLA 3.75mm plastic filament.

Working principle:
Here I am trying out a sort of "aluminum joint" where a red coupling is used to grip the aluminum rods and from joints without the usage of welding, or machining, here I have used PVC piping as I do not have any aluminum pipes at home, but at the workshop we have aluminum pipes available, so in this section I would like to test whether the aluminum frame is still feasible.

Functional Explanation:
The "joint" works by having to coupled pieces that go around the aluminum pipes, and are held together using friction and pressure from the tightening of the bolts, Here I have used M4 nuts and bolts, however I have not cut them short as to not waste them. There is a slot for the nut to slide into so that there is no need for a spanner, however the whole was too small and so I simply placed the nut on the bottom, however in a final prototype heated inserts would be using (figure 15.1) as they are more practical and would be installed by using a soldering iron to heat the heated insert and push into the plastic (figure 15.2)

Figure 15.1

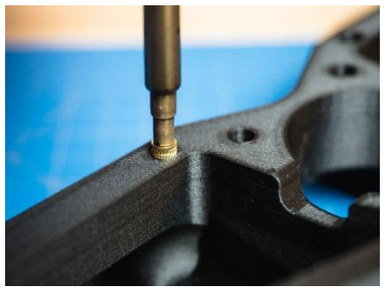
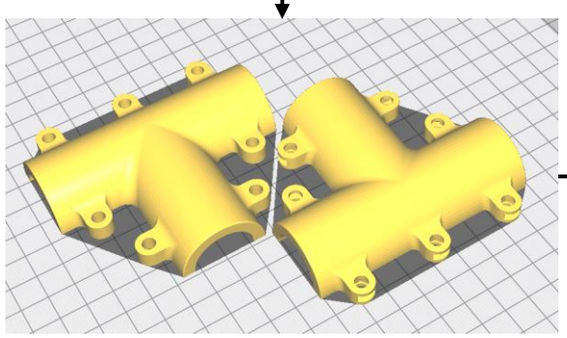


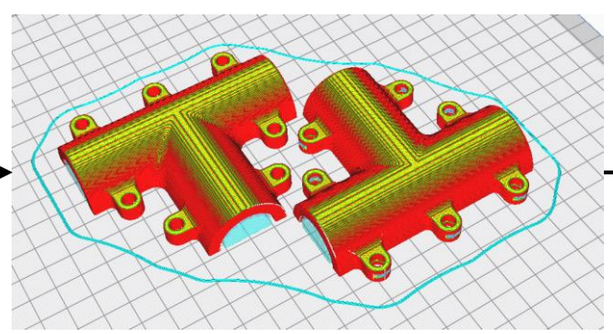
Figure 15.2

(7) Shows the support structure used in the printing of the two components

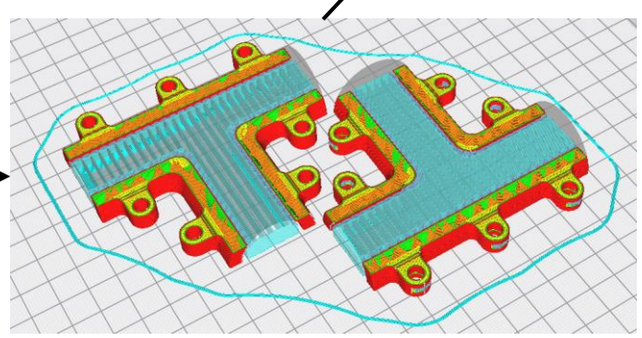
Summary:
After completing this section I have made sure that I am choosing the right materials as here the plastic joint is too weak and the frame wont be able to support its own weight due to this, and so this means that wood must be used instead of aluminum.



(3)

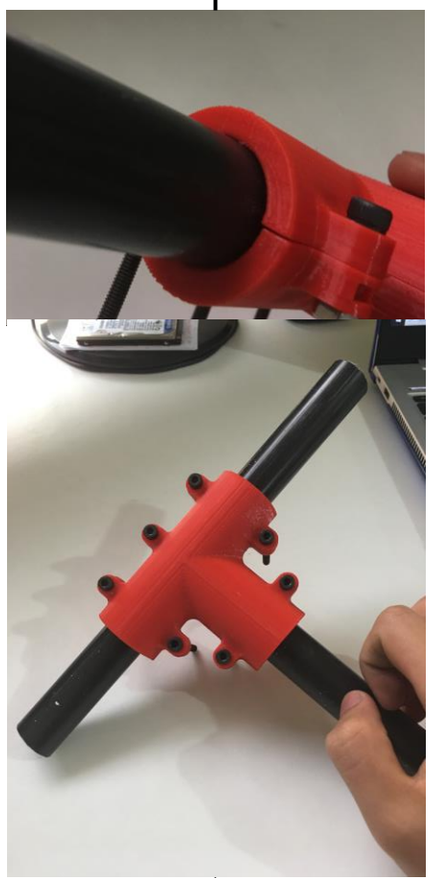


(4)



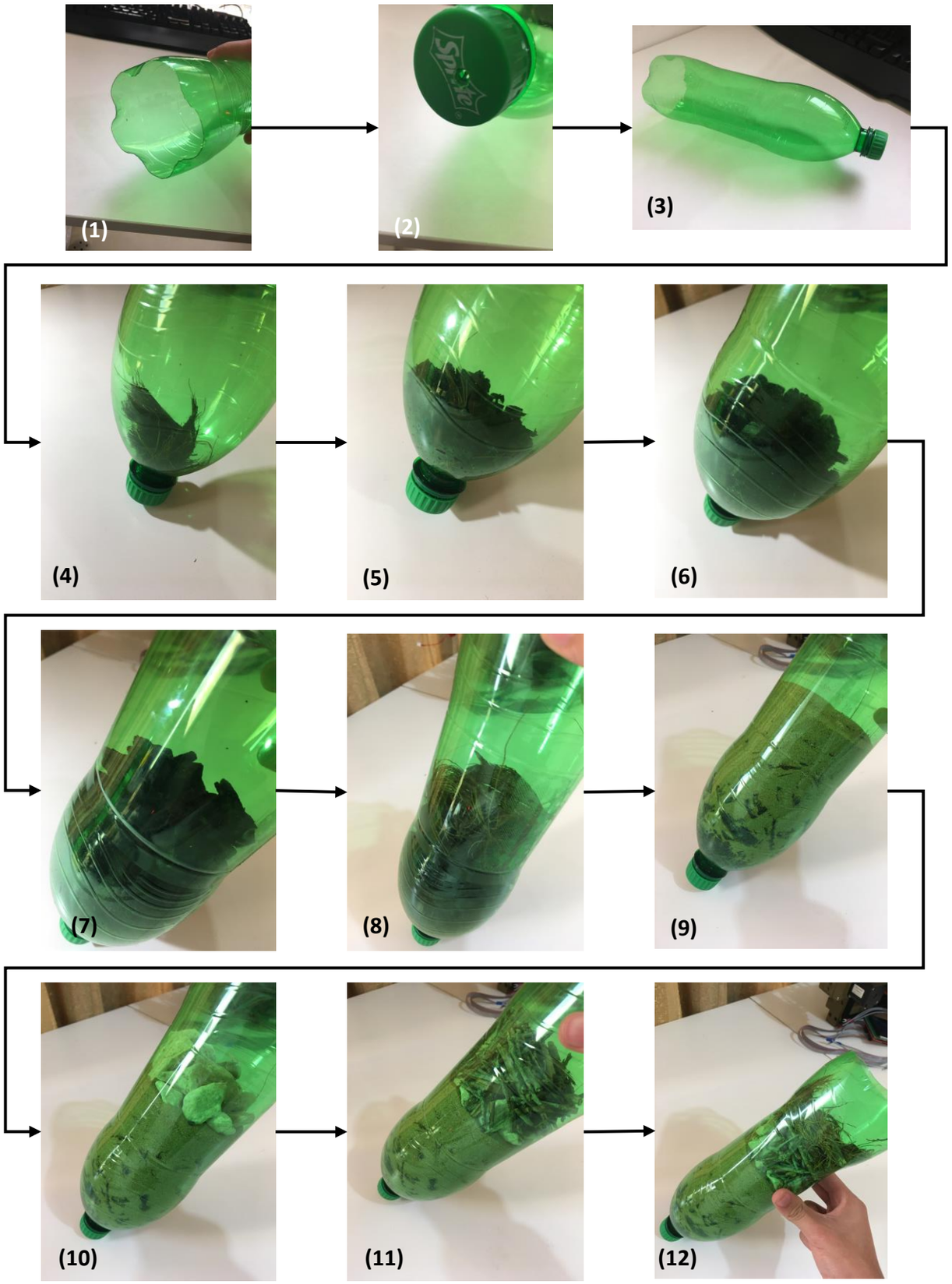
(5)

(7)



(6)

(40) Development (Filter Making)



Materials:
The materials (figure 16.1) used in this filter are quite common and can easily be substituted with other materials if not available. From top left to bottom right there are long twigs, short twigs, sand, small rocks, tree husk, coarse charcoal, finer charcoal, fine charcoal.

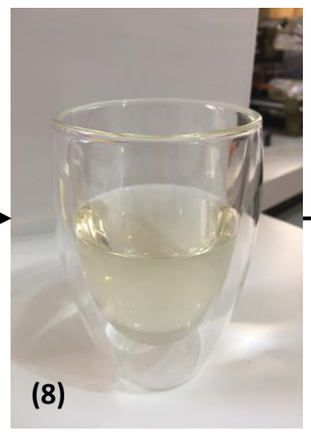
Figure 16.1

Filter Assembly:
(1) The top of the bottle is cut off using scissors.
(2) The bottom of the bottle's cap has a small hole inserted using a soldering iron.
(3) This is the final bottle after modification
(4) A rock and then husk is inserted to prevent and sand or sediments from leaking through to the clean water.
(5) Fine charcoal is placed in the bottle.
(6) Less fine charcoal is placed in the bottle.
(7) Coarse charcoal is placed in the bottle
(8) Husk is placed on top of the charcoal to block the sand from falling through down.
(9) Sand is placed over this.
(10) Rocks are placed over this
(11) Small Twigs are placed over the rocks, and then lastly more husk is place and the large twig is used to compress the husk down to prevent any large particles from getting through.

Uses of the different layers:
Large twig is used to compress the husk. Small twig is used to filter out very large particles, the sand filters out the smaller particles, the charcoal removes odor and bacteria from the water after many passes, the coarse, somewhat fine, and fine charcoal are used to also filter out particulate at the same time. The rocks are used to provide structure to the filter to prevent the sand from moving down into the filter, and also again remove and large particles.

Summary:
After completing this section of the development I now know what will be required to make the filter, and in the next section I will test this filter allowing me to gauge any shortcomings of the filter design and then address them in the final prototype design.

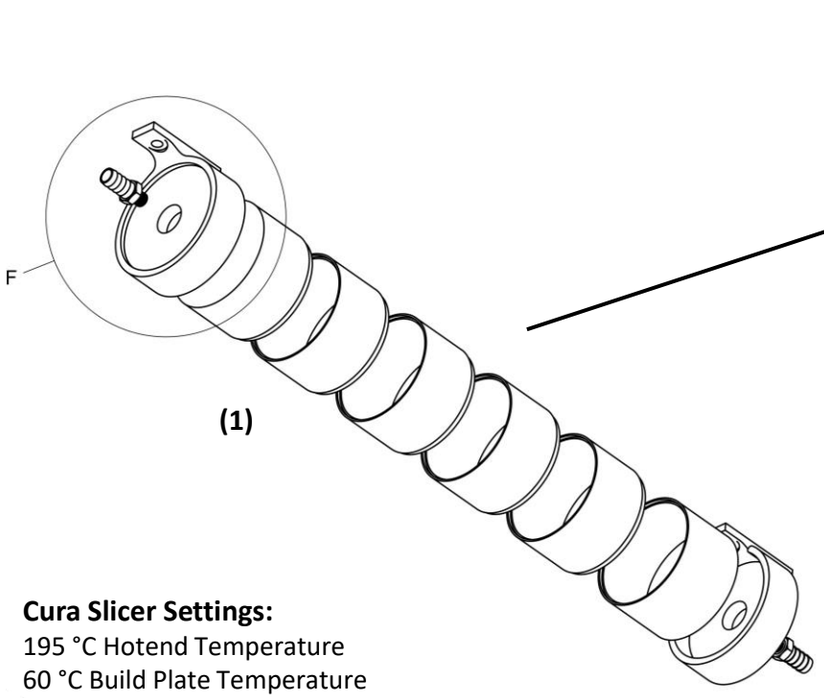
(41) Development (Filter Testing)



Filtering Process:
The process for each iteration takes about 15 minutes to completely run through one batch of water, this means that the material in the filter needs to be more tightly packed in, and also **a** longer filter may be needed to reduce the iterations required. However, some of the coloration in the water was caused by natural pigments from the husk escaping into the water, and after placing a few “cleaning run” of tap water into the filter the dirty water came out much clearer after that. We would most likely need two iterations to have safe drinking water.

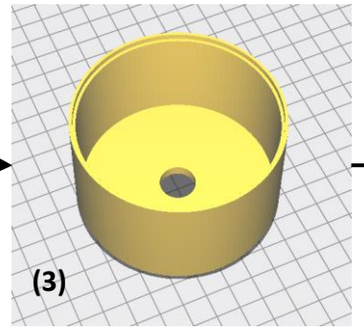
Summary:
After completing this section of the development I have a greater understanding of the working principle behind the water filter and I have also figured out the optimum depth and diameter of filter to perfectly filter out the water. Moreover I am now armed with the knowledge that for the filter to be functional it will need to be run through 4-5 times using clean water to obtain color-free water.

(42) Development (Finalized Filter)

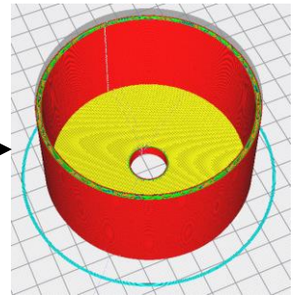


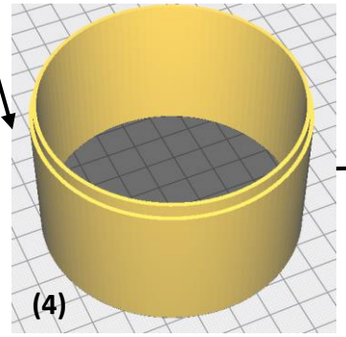
(1)

(2)

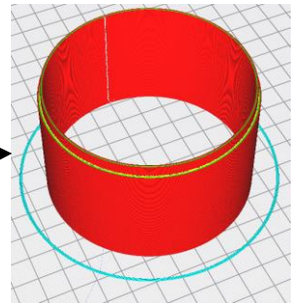


(3)





(4)



Cura Slicer Settings:
195 °C Hotend Temperature
60 °C Build Plate Temperature
95 mm/s Feedrate
0.3 Layer Height
No Supports
Infill at 25% and Cubic
Build Plate Adhesions is Skirt

The parts are printed in PLA 3.75mm plastic filament.

Filter Working Principle:
The filter will slot into each other and then using the two they would compress the filter and prevent leaks. Moreover in there has been a space designed in between the two lips where a rubber O ring to increase the seal quality of the water filter.

Usage of the filter:
The filter will contain pieces of cloth between each lip to prevent the different layers from mixing ex. such as the sand layer falling through. Moreover the diameter and length of each layers has been optimized to make the filter able to contain two passes in one pass thus meaning the water that will come out will be as clean as possible.

Summary:
After completing this section of the development, I now have a finalized design for the water filter, thus reducing the time required for designing the final water catcher. The filter will slot into each other and then using the two they would compress the filter and prevent leaks.

(43) Development (Assembly Booklet)

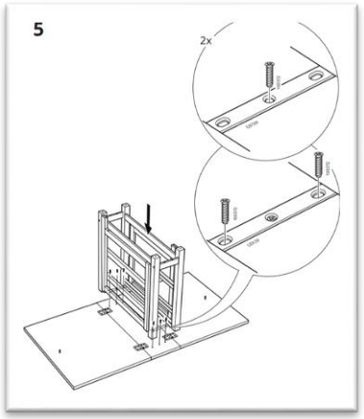


Figure 17.1

RESEARCH

ABB

Figure 17.2

Inspiration:
Figure 17.1 shows step 5 from a random item's instructional manual made by IKEA. IKEA has set design principles that I have followed in my instruction booklet such as:

(1) Showing the physical number of components needed meaning if you counted 12 nuts on the paper then you would need 12 nuts in the assembly process.

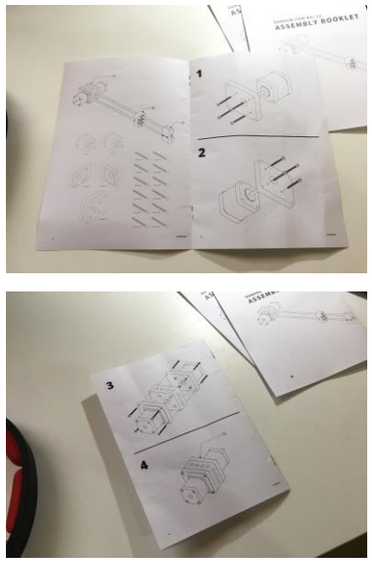
(2) Making the instruction manuals language friendly meaning you do not need to understand ex. English to know to assemble the product.

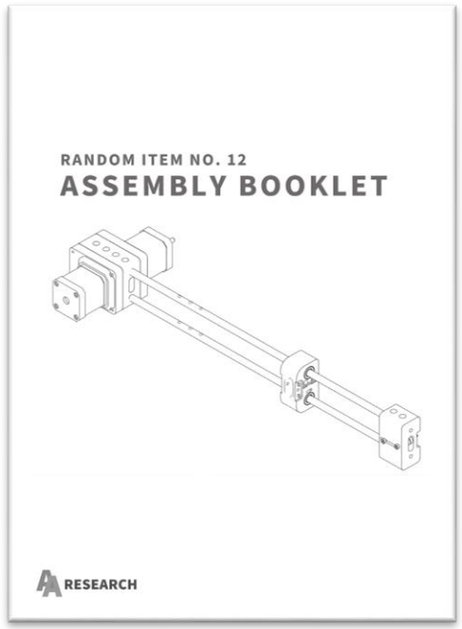
(3) The instruction manual predicts the common mistakes and tell you not do them by putting a large cross over them again preventing user confusion in the process and making their instructions clear and explicit.

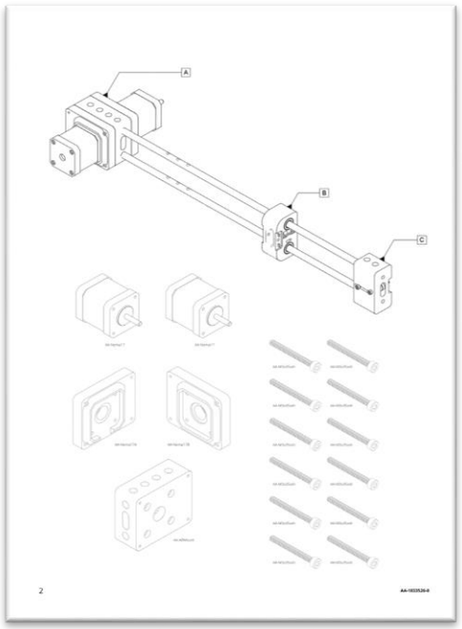
Assembly Booklet:
The isometric drawings here are from another completely unrelated project, but I have used these working drawings as they are the only ones I had available without design the final water catcher. I have followed the IKEA instruction manual design principles and have tried to stay true to this tried and tested method.

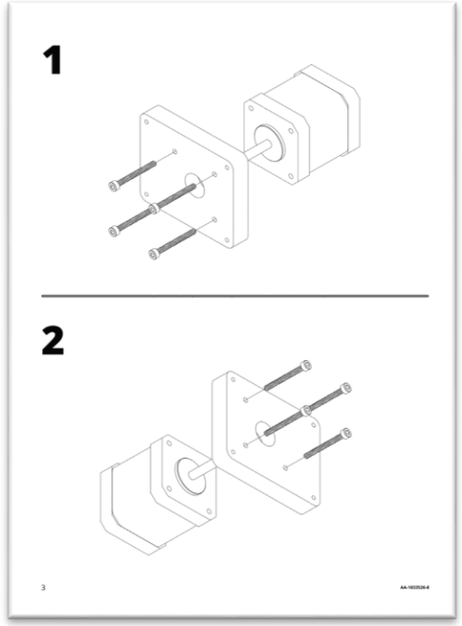
Logo:
I have created a sort of brand name that allows customers to easily recognize the product and place the design under an specific name. The logo is somewhat akin to that off the ABB logo in figure 17.2.

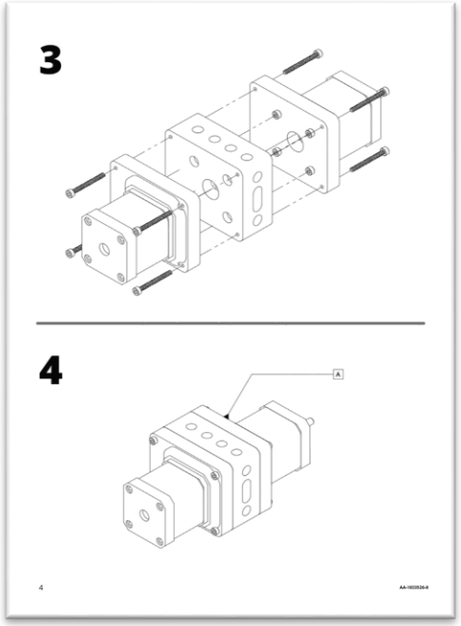
Printing:
I have used Adobe Acrobat (legacy) to print out the booklet, however this was a very painful process as this program is unable to arrange the pages so that it will print easily in a booklet form and so I had to arrange them myself which is time consumer for large booklets. In the final printing I will use Adobe DC instead as it has an auto arrange booklet function.











Summary:
After completing this section of the development section I know have established a style for the assembly booklet which will then be used to ultimately make the final assembly booklet of the water catcher. I have also identified a more suitable program to print the booklet out in for the final printing for the final booklet for the water catcher.

Conclusion:
After completing this section of the NEA, I now have improved the initial design of the water catcher into something more refined, and this has allowed me to learn new knowledge in this section which will then ultimately all help me finalize the design of the prototype.

Moving Forward:
In the next section, I plan to detail the working drawings of the final water catcher prototype, the BOM, cutting list, and the layout for the assembly booklet.

(44) Development Review (Summary of Response to Feedback)

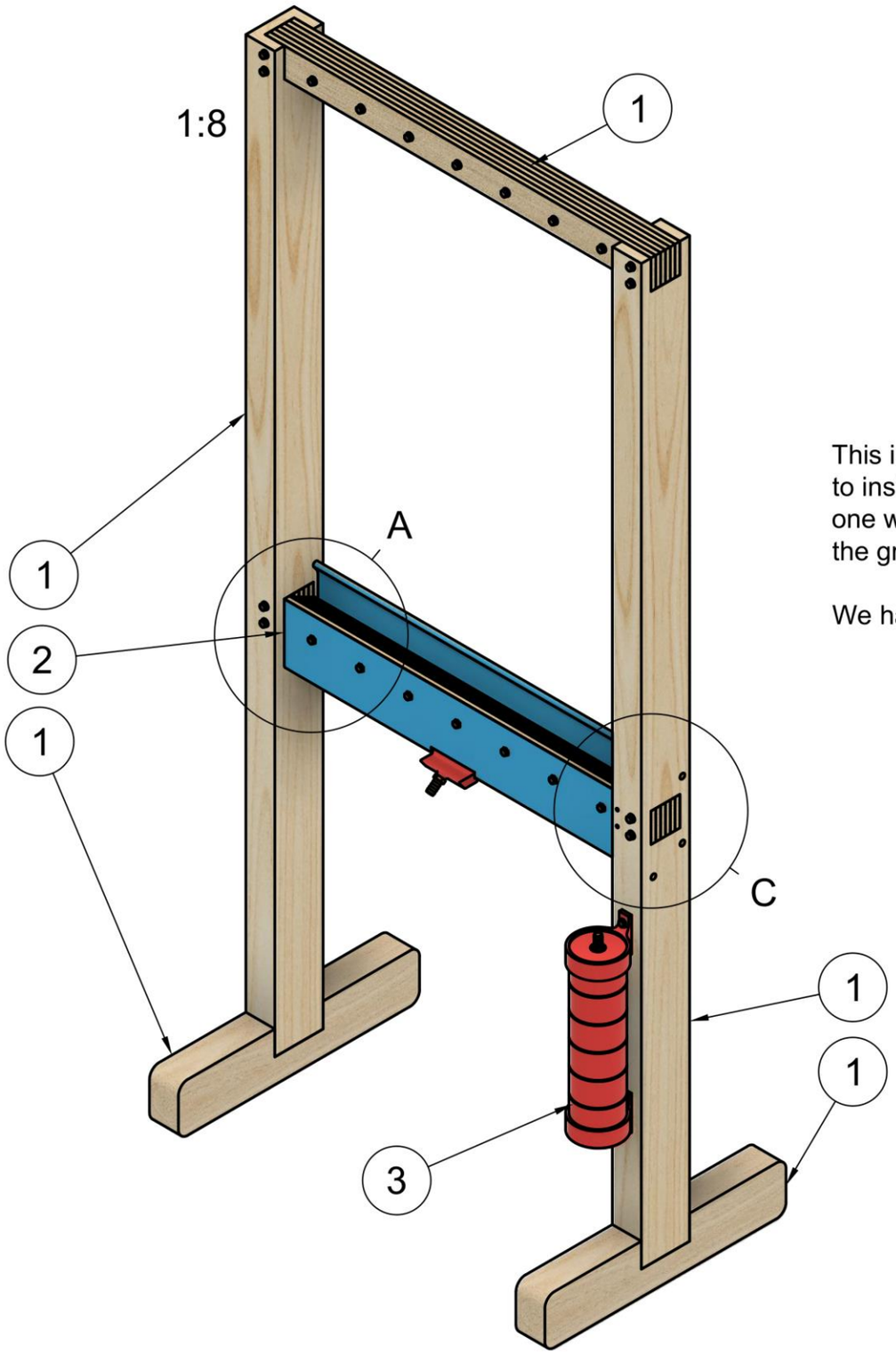
Introduction:
In the development Review I plan to summarize how I have addressed my client/user's feedback from the initial design in the development section.

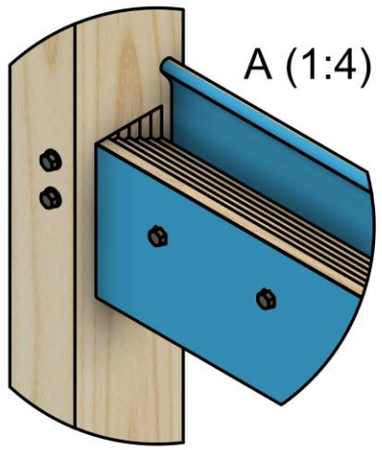
Feedback for development sections	Response to the feedback
(1) "Perhaps include a filter to make sure that water is 100% safe to drink" (2) "How exactly will the net attach to the frame?" (3) "What type of joinery will be used in the frame? I also believe that welding may not be suitable as it is permanent and perhaps the device may need to be disassembled later" (4) "At the moment the design is quite ugly looking, and may be an eyesore, perhaps using more muted colours that complement the local environment may be beneficial to reduce visual clutter." (5) "Perhaps making the design modular may be beneficial to improve it's capacity and thus allow the design to be adapted to the community it is deployed into." (6) "Our workshop may not have any aluminium available and we may not be able to machine, cut, or weld it. A different material type for the frame may need to be considered." (7) "Perhaps including a visual and language friendly assembly booklet ay be beneficial to the design as it may aid user's in assembling the final prototype, and will also provide a manual for potential repairs."	(1) I have made, tested, and designed a final filter that will be able to filter out contaminants out from the water. (2) I have developed six different types of net mounting systems, and these have allowed me to create a rough draft for the proper final net mounting system. (3) I have explored joinery for both types of frame, I have explored different types of wood joinery, and have also explored aluminium substitute joinery that can replace the welding part of the project thus making the project more feasible. Overall I have decided to move forward with the wood frame as the compromise aluminium joinery is not strong enough and may remove rigidity of the frame. The wooden frame will contain no permanent joinery methods. (4) The design contains more muted colours now, especially with the use pine wood. (5) I have explored methods of making the design more modular and have brainstormed ideas on incorporating modularity into the design to help tailor the device to different communities and use cases. (6) I have developed a completely new frame which uses wood instead of aluminium. I have also developed it's wood joinery. (7) I have developed a visual style for a future assembly booklet.

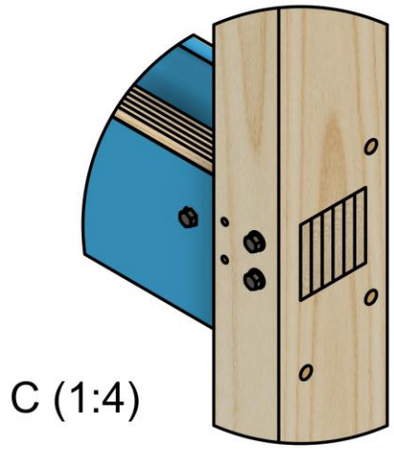
Conclusion:
After completing this page, I now have an idea if I have missed any feedback points which will allow me to address them while designing the final design, thus making sure that all my client/user's needs and wants are all met.

Moving Forward:
In the next section I plan to detail the final design in its completion after taking the lessons learned from the investigation and development phase and designing a complete prototype that addresses my clients/user's needs and wants wholly.

(45) Final Design Overview







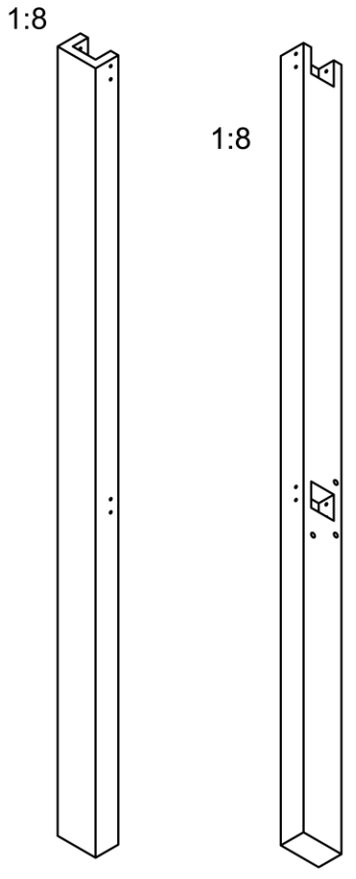
This is the final and complete Water Catcher Prototype. Some major improvements would be to instead use aluminium for its lower weight, cost at large quantities, durability, etc. another one would be to substitute the placeholder support legs with a proper system that digs into the ground, or bolts into concrete for strength.

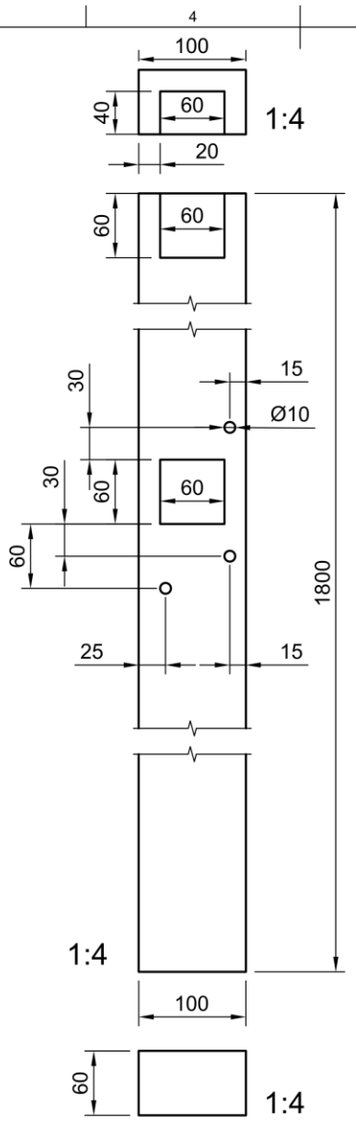
We have not done these changes as:

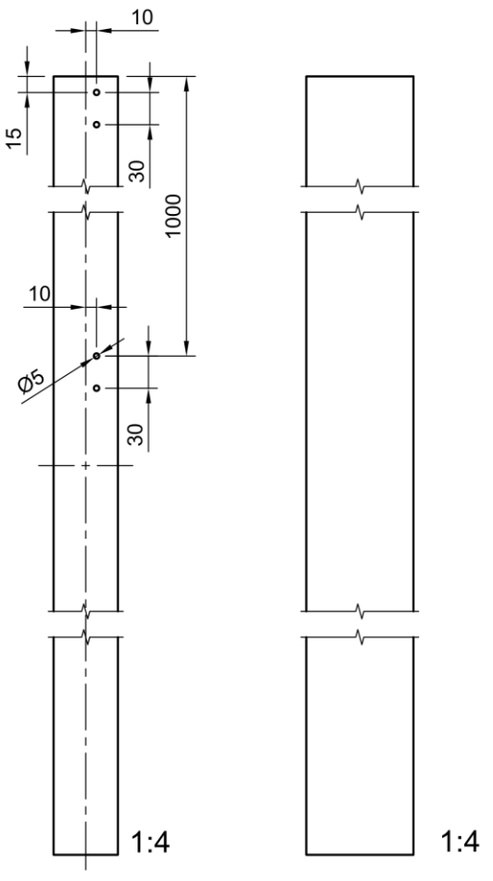
(1) We have ran out of time due to the pandemic reducing the manufacturing phase of the project, and thus some changes have been done to the design to reduce complexity.
(2) We do not have the facalities availible to weld, shape, drill, and cut aluminium, hence we have compromised with a wood frame.
(3) The proper ground mounting system has been replaced with placeholders as the prototype would be too unweildy and large with a proper ground mounting system, we also have no way of testing such a system as we do not have concrete mounting points nor suitable soil for digging the supports into the ground.

Parts List			
Item	Qty	Part Name	Description
1	1	Frame Assembly	
2	1	Tarp Assembly	
3	1	Filter Assembly	

Dept.: ABA DT	Technical reference: ---	Created by: Ayan Ali 20/03/2022	Approved by: --- ---
		Document type: Isometric	Document status: Final Drawing
AA RESEARCH		Title: Water Catcher Prototype Main Assembly	DWG No.: wc_final (v9)
			Rev.: 0 / Date of issue: 20/03/2022 / Sheet: 1/27

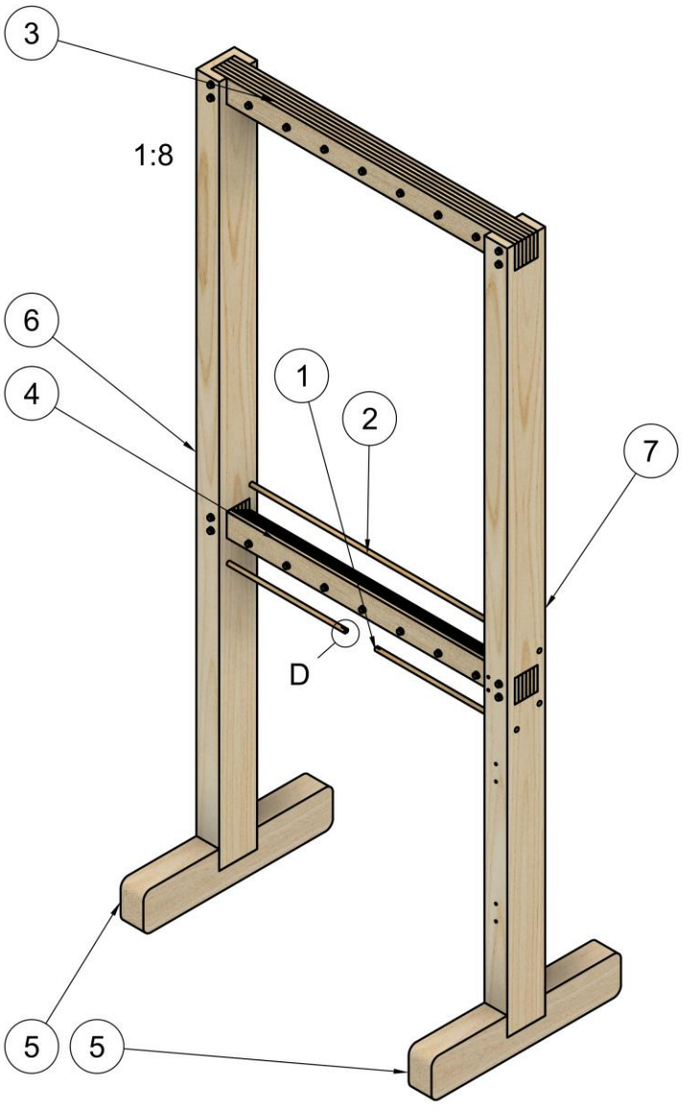


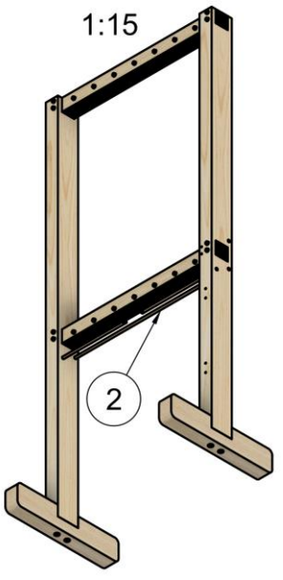




Dept. ABA DT	Technical reference ---	Created by Ayan Ali 20/03/2022	Approved by --- ---
RESEARCH		Document type (Vertical Support Closed Type)	Document status Final Drawing
		Title Water Catcher Prototype Frame SubAssembly	DWG No. wc_final (v9)
			Rev. 0 / Date of issue 20/03/2022 / Sheet 3/27

(46) Final Design Working Drawings



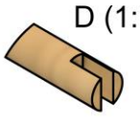


To calrify, the design consists of three dowels, it contains two item 2 dowels, and one item 1 dowel.

The item 2 dowels are put in palce to allow the tarp to wrap around thus making a sort of catching sustem for thwater, this is also why the Bottom Horizontal bar is also slanted, as it will be sanded smooth to make a ramp down into the tarp, which will collect the water and take it to the funnel which will route it into a pipe.

The split dowel, or the item 1 dowel had a notch in it that alows it to latch with the red funnel in the Tarp SubAssembly.

D (1:1)



Parts List

Item	Qty	Part Name	Description
1	1	Funnel Dowel (Split)	
2	2	Dowel	
3	1	Top Horizontal Bar	
4	1	Bottom Horizontal Bar	
5	2	Placeholder Support	
6	1	Vertical Support Closed Type	
7	1	Vertical Support Open Type	

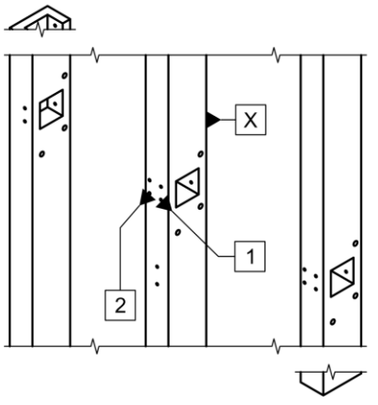
Dept. ABA DT	Technical reference ---	Created by Ayan Ali 20/03/2022	Approved by --- ---
RESEARCH		Document type Isometric	Document status Final Drawing
		Title Water Catcher Prototype Frame SubAssembly	DWG No. wc_final (v9)
			Rev. 0 / Date of issue 20/03/2022 / Sheet 2/27

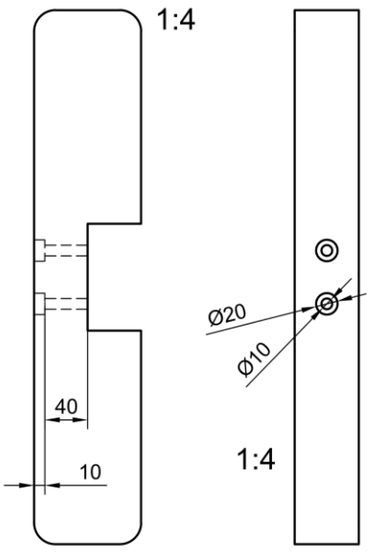
Elaboration of vertical support types:

So for the device to be modular new vertial support beams can be added adacently to the already existing two beams thus increases the capacity of the water catcher.

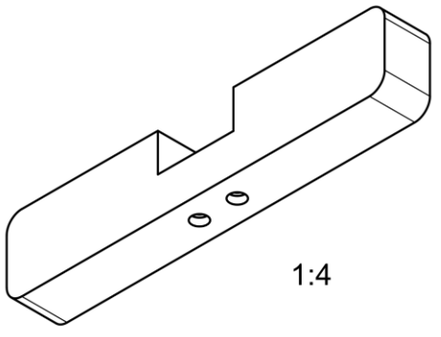
There are two sets of holes in the open type vertical support, one is for a vertical beam that only has one horiontal bar, and the second hole for if there are two horizontal bars due to another module being added on adjacently to the vertical support bar.

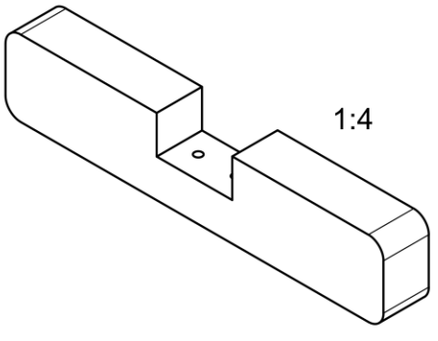
A diagram is shown on the right:

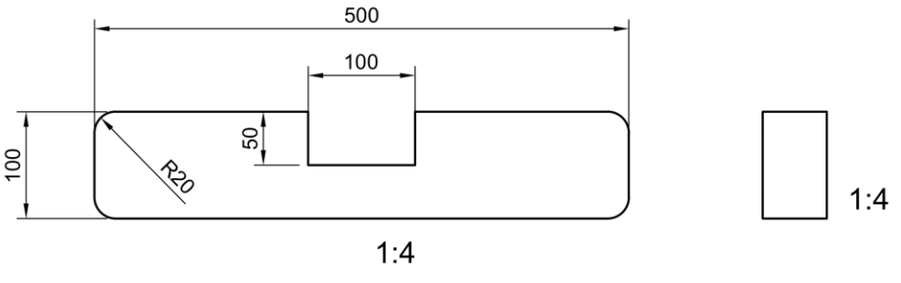




If the water catcher is used pwith only one module or net, then only holes 2 are used to bolt the singular horizontal bar, and the edge of the bar will be flush against X, however if two modules or more are used then only half of the horizontal bar will go through giving space for the other horizontal bar to go through too and each bar will be bolted to 1 and 2 respectively.



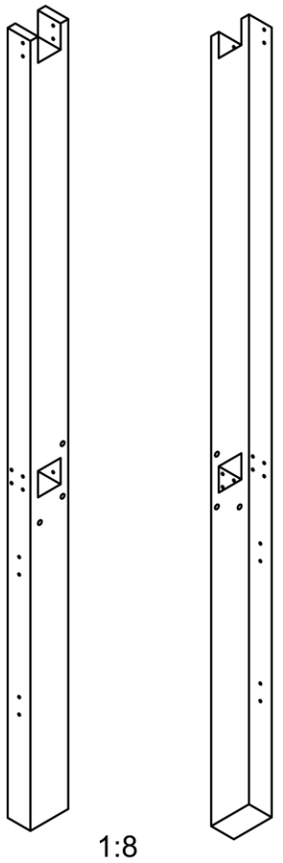


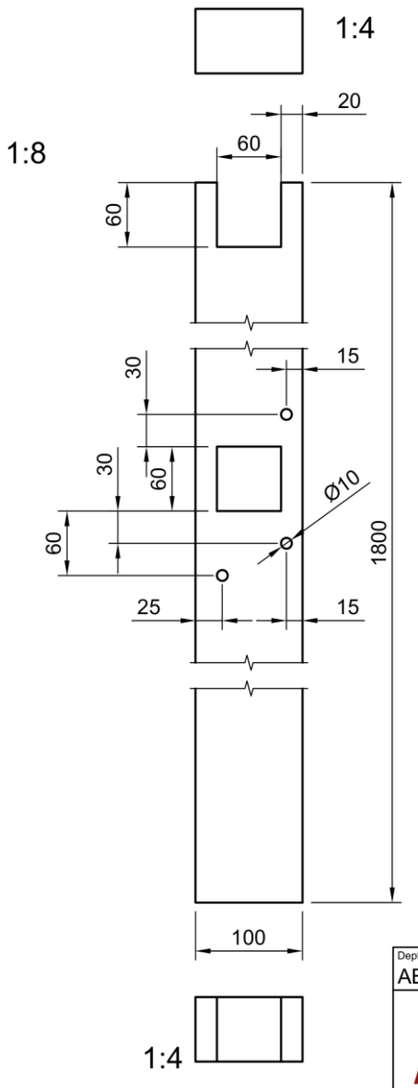


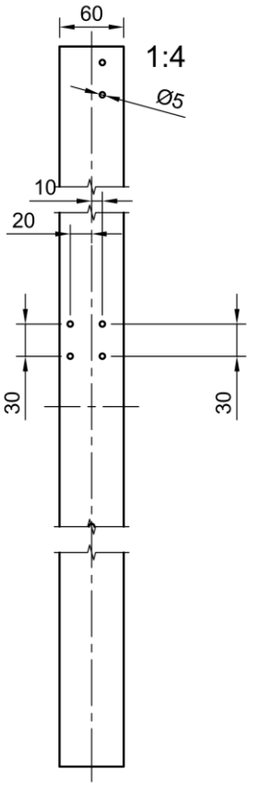
Dept.	Technical reference	Created by	Approved by
ABA DT	---	Ayan Ali 20/03/2022	--- ---
		Document type: (Placeholder Support)	Document status: Final Drawing
AA RESEARCH		Title: Water Catcher Prototype Frame SubAssembly	DWG No.: wc_final (v9)
			Rev.: 0 / Date of issue: 20/03/2022 / Sheet: 5/27

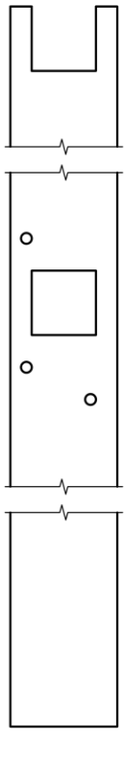
(47) Final Design Working Drawings (Continued)

There are two types of vertical support beams, one that is open and one that is closed, in the final product the closed beams will act as end stops to a large array of filters that are connected modularly, this is also why there are two sets of holes for the horizontal support bars in different positions, this is further elaborated on in the placeholder support section

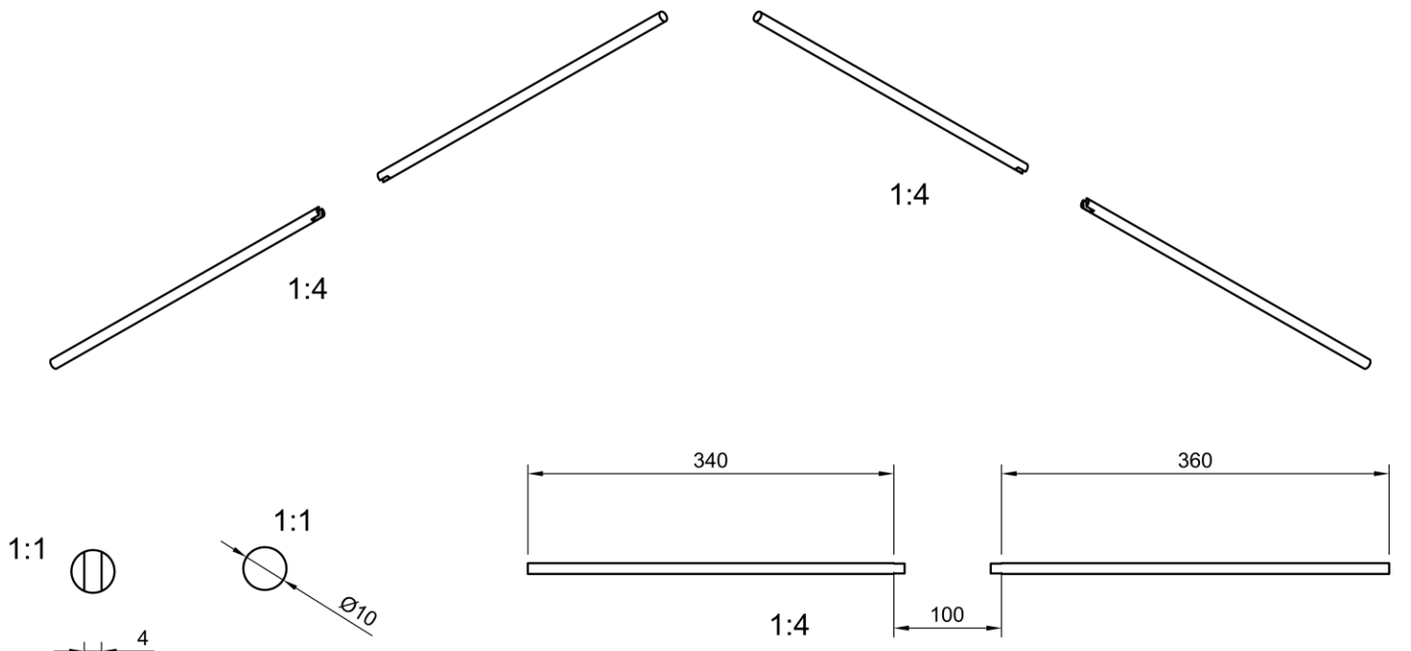


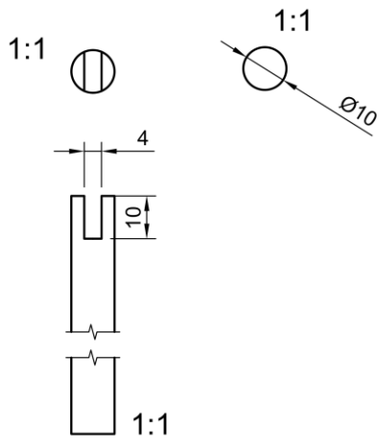






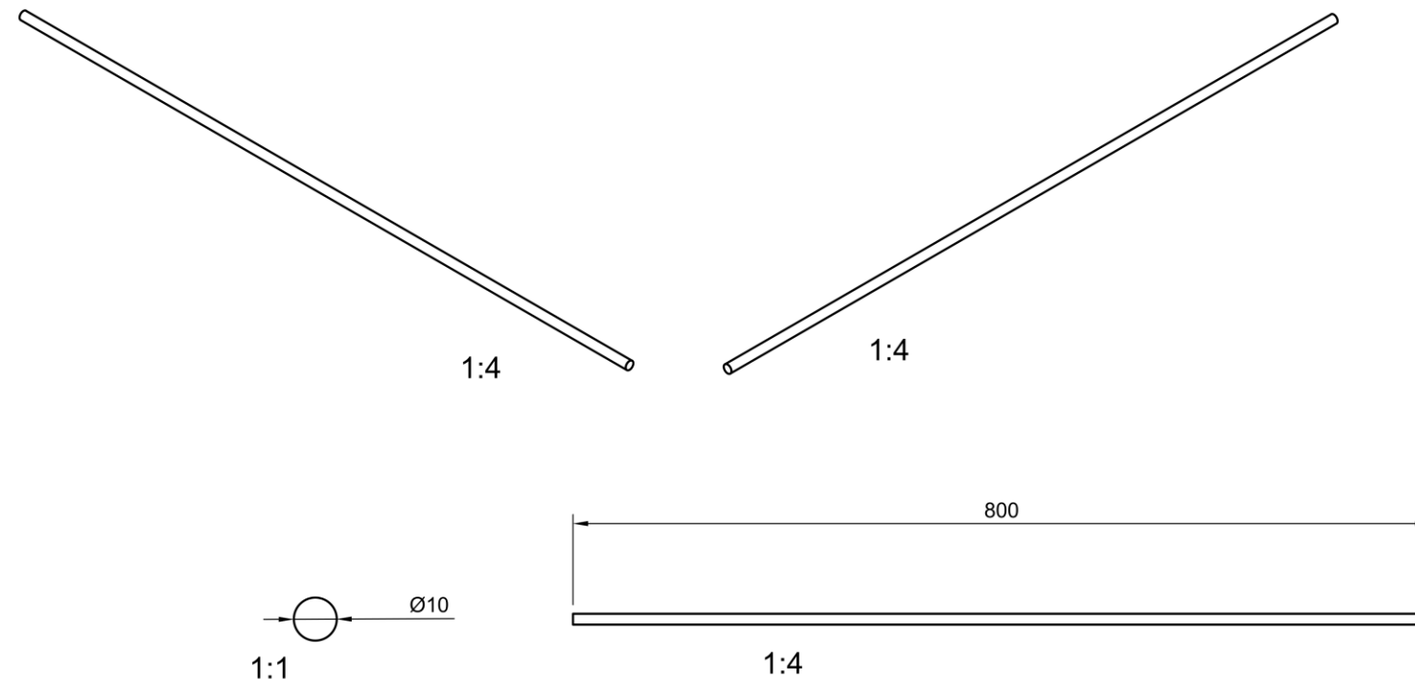
Dept.	Technical reference	Created by	Approved by
ABA DT	---	Ayan Ali 20/03/2022	--- ---
		Document type: (Vertical Support Open Type)	Document status: Final Drawing
AA RESEARCH		Title: Water Catcher Prototype Frame SubAssembly	DWG No.: wc_final (v9)
			Rev.: 0 / Date of issue: 20/03/2022 / Sheet: 4/27



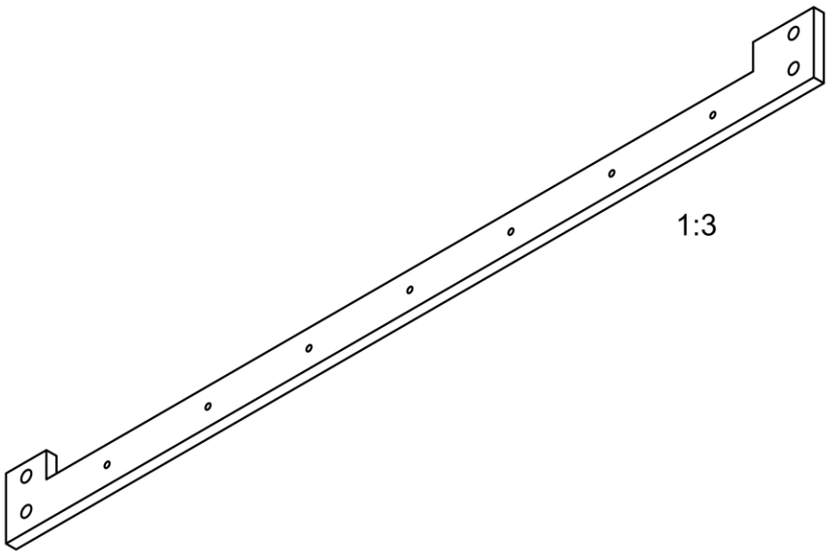


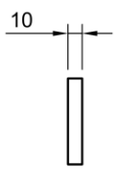
Dept.	Technical reference	Created by		Approved by
ABA DT	---	Ayan Ali	20/03/2022	--- ---
AA RESEARCH		Document type: (Dowel Split)		Document status: Final Drawing
		Title: Water Catcher Prototype Frame SubAssembly		DWG No.: wc_final (v9)
			Rev.: 0	Date of issue: 20/03/2022
				Sheet: 7/27

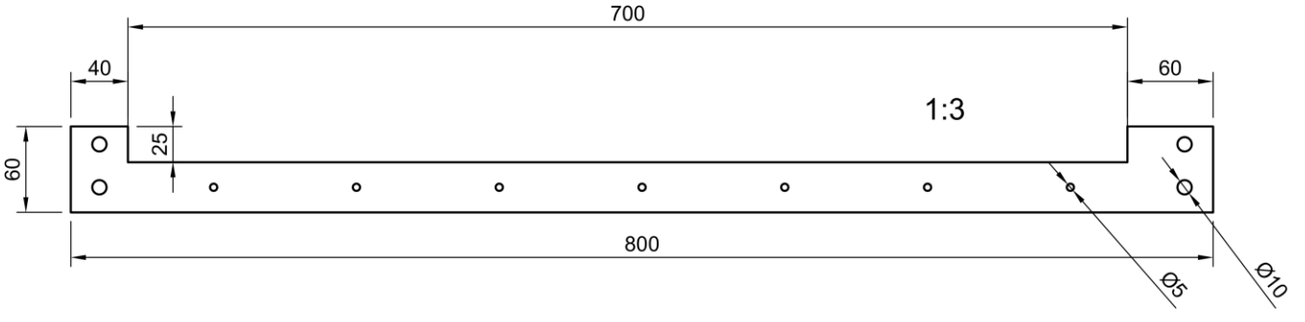
(48) Final Design Working Drawings (Continued)



Dept.	Technical reference	Created by		Approved by
ABA DT	---	Ayan Ali	20/03/2022	--- ---
AA RESEARCH		Document type: (Dowel)		Document status: Final Drawing
		Title: Water Catcher Prototype Frame SubAssembly		DWG No.: wc_final (v9)
			Rev.: 0	Date of issue: 20/03/2022
				Sheet: 6/27







Dept. ABA DT	Technical reference ---	Created by Ayan Ali 20/03/2022	Approved by --- ---
AA RESEARCH		Document type (Section 2.5cm Cut)	Document status Final Drawing
		Title Water Catcher Prototype Bottom Horizontal Bar SubAssembly	DWG No. wc_final (v9)
			Rev. 0 / Date of issue 20/03/2022 / Sheet 9/27

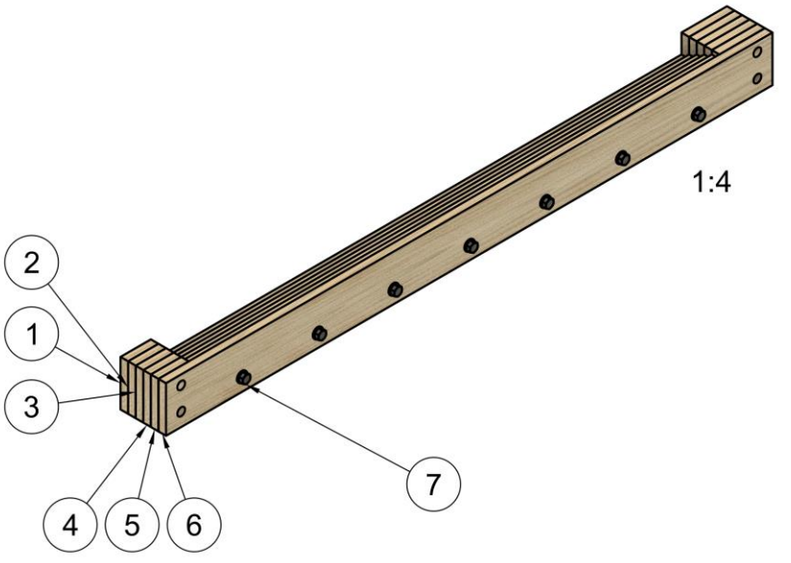
(49) Final Design Working Drawings (Continued)

There are six different sections of plank in the bottom horizontal bar, each with a different "cut" inside of them, there are:

(1) Section 2.5cm Cut
(2) Section 2.0cm Cut
(3) Section 1.5cm Cut
(4) Section 1.0cm Cut
(5) Section 0.5cm Cut
(6) Section No Cut

The six different sections form the horizontal support bar and they had two purposes, the yfirstly act as a sturcutural peice between the two vertical support beams, and secondly they have holes inside of them that allow bolts to pass through which can tightly clamp 5 pieces of net between the six sections.

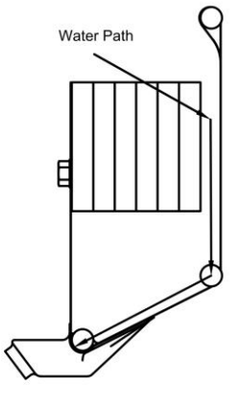
The bottom horizontal piece acts as the clamping part, while the top horizontal bar is adjustable as it is easier to get to. This allows the user to be able to get the exact tension in the net as needed.



The bottom Horizontal piece has six different pieces as they form a sort of ramp to allow the water to roll down into the tarp, and then into a 3D printed funnel for collection.

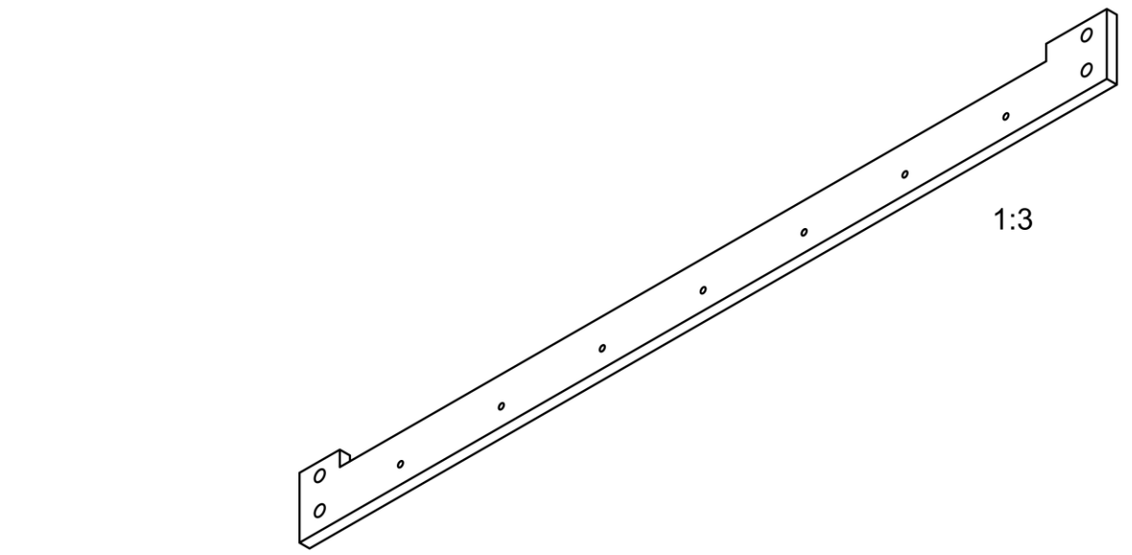
The path of the water is shown on the right:

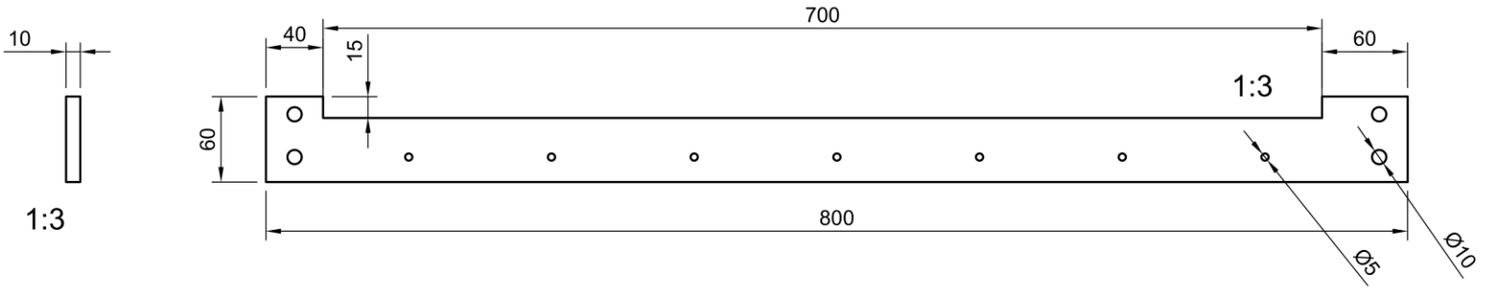
(The ramp is not shown, but the water goes in that direction)



Parts List			
Item	Qty	Part Number	Description
1	1	Section (2.5cm cut)	
2	1	Section (2cm cut)	
3	1	Section (1.5cm cut)	
4	1	Section (1cm cut)	
5	1	Section (0.5cm cut)	
6	1	Section (No cut)	
7	7	Hex M6 6cm Cut Screw	

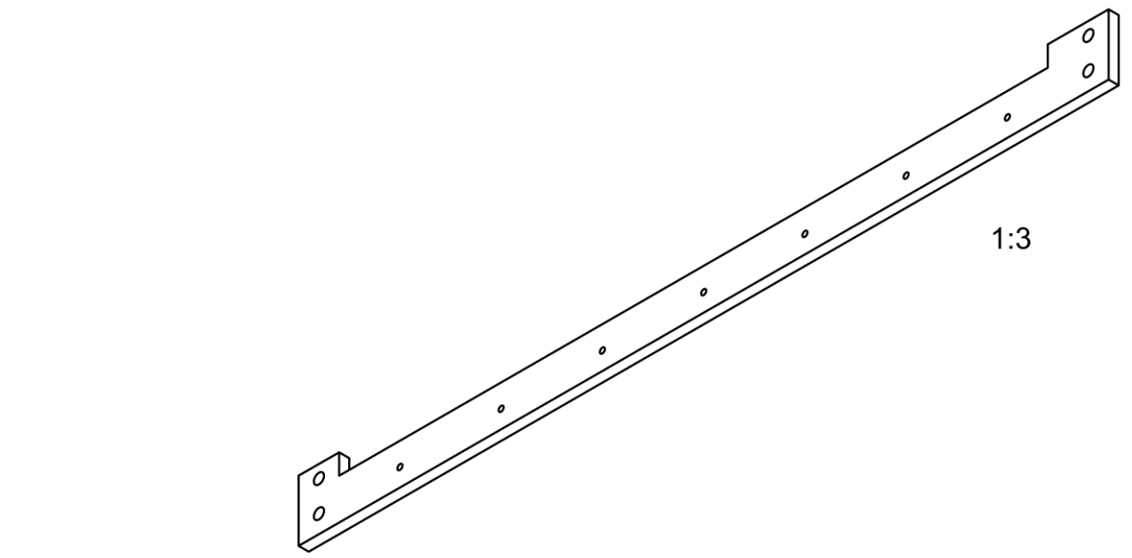
Dept. ABA DT	Technical reference ---	Created by Ayan Ali 20/03/2022	Approved by --- ---
AA RESEARCH		Document type Isometric	Document status Final Drawing
		Title Water Catcher Prototype Bottom Horizontal Bar SubAssembly	DWG No. wc_final (v9)
			Rev. 0 / Date of issue 20/03/2022 / Sheet 8/27

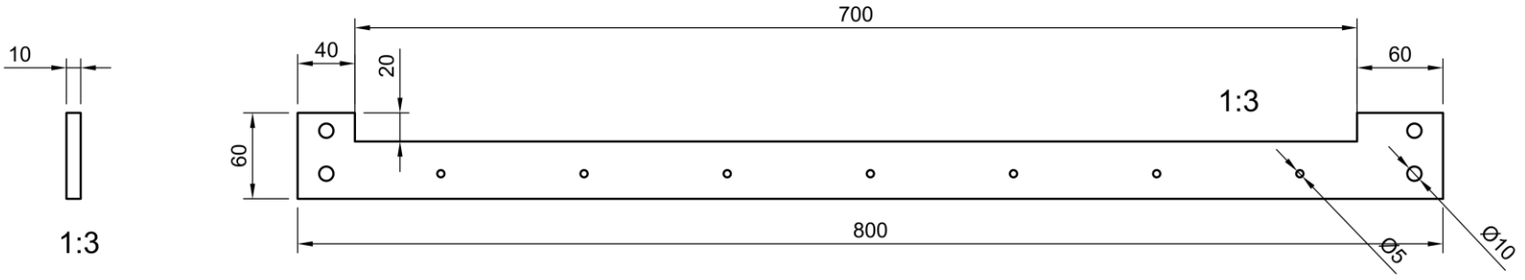




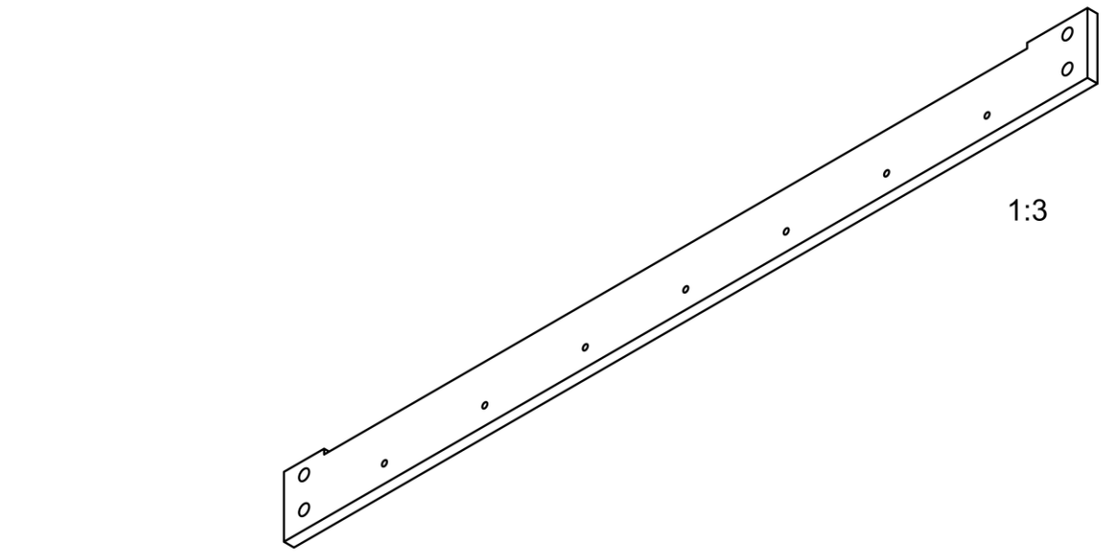
Dept.	Technical reference	Created by	Approved by
ABA DT	---	Ayan Ali 20/03/2022	--- ---
		Document type: (Section 1.5cm Cut)	Document status: Final Drawing
RESEARCH		Title: Water Catcher Prototype Bottom Horizontal Bar SubAssembly	DWG No.: wc_final (v9)
			Rev. 0 / Date of issue 20/03/2022 / Sheet 11/27

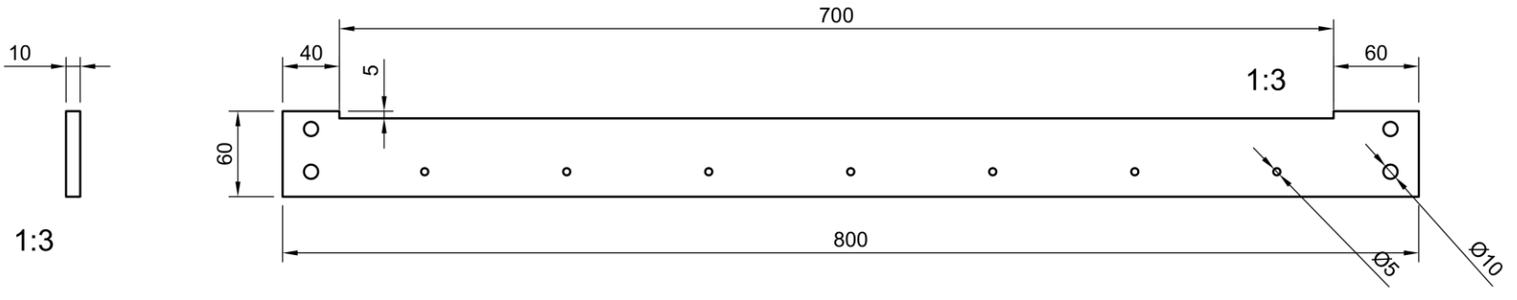
(50) Final Design Working Drawings (Continued)



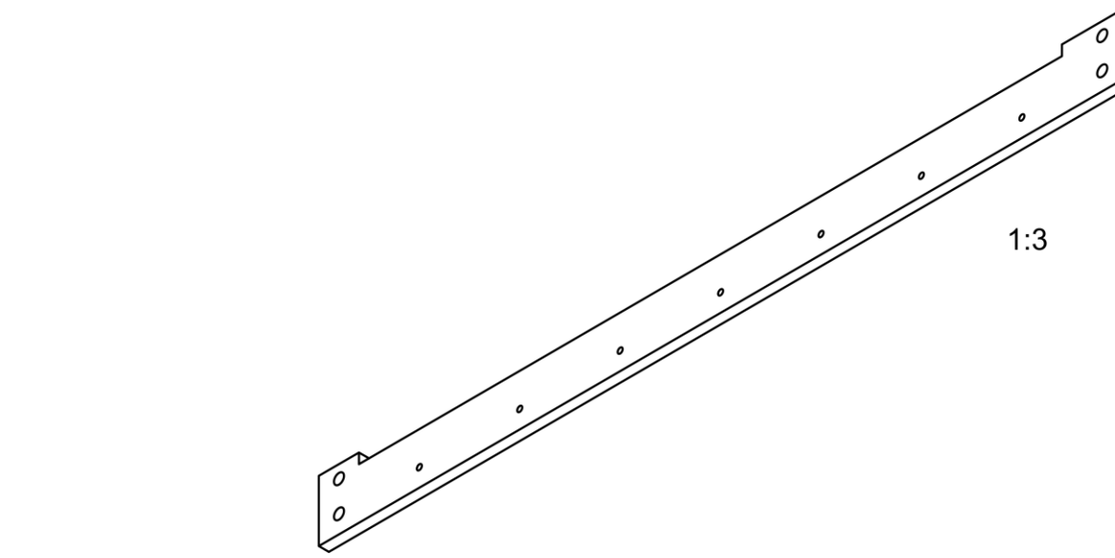


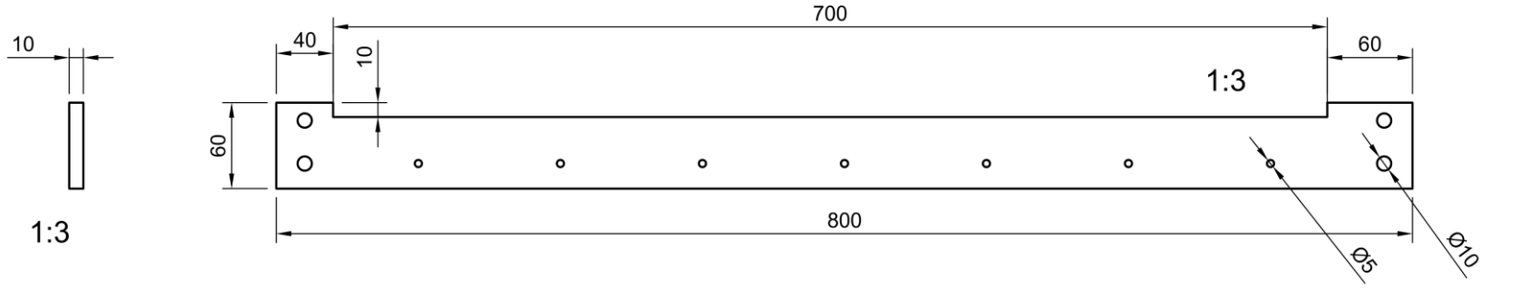
Dept.	Technical reference	Created by	Approved by
ABA DT	---	Ayan Ali 20/03/2022	--- ---
		Document type: (Section 2cm Cut)	Document status: Final Drawing
RESEARCH		Title: Water Catcher Prototype Bottom Horizontal Bar SubAssembly	DWG No.: wc_final (v9)
			Rev. 0 / Date of issue 20/03/2022 / Sheet 10/27



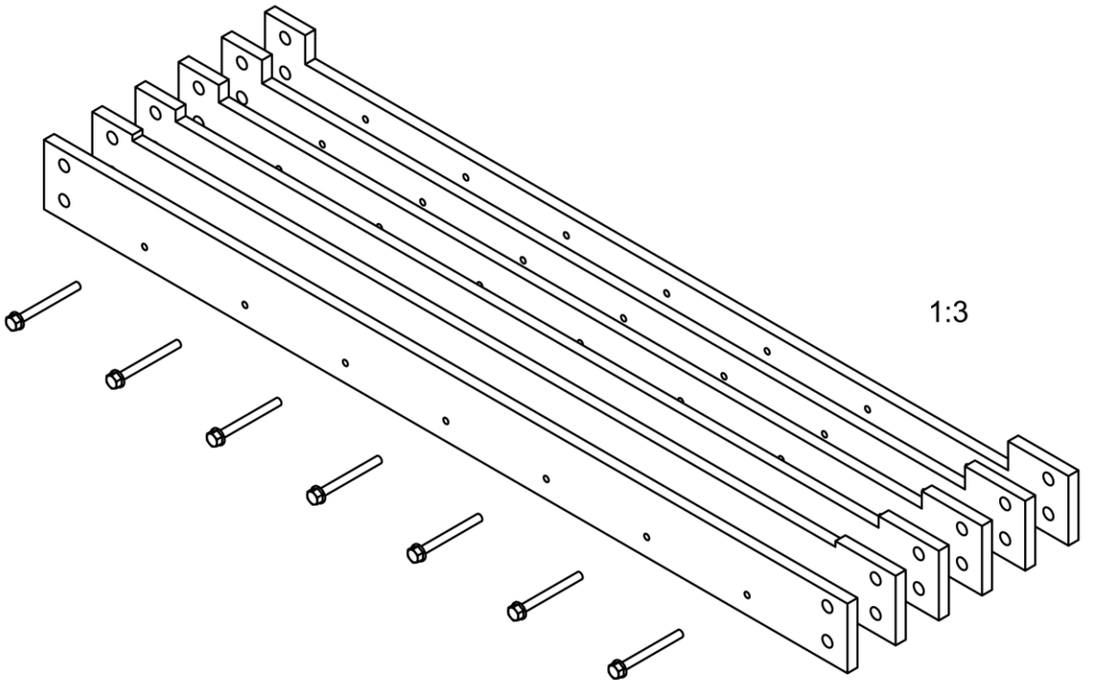


Dept.	Technical reference	Created by		Approved by	
ABA DT	---	Ayan Ali	20/03/2022	---	---
		Document type: (Section 0.5cm Cut)		Document status: Final Drawing	
RESEARCH		Title: Water Catcher Prototype Bottom Horizontal Bar SubAssembly		DWG No.: wc_final (v9)	
				Rev.: 0	Date of issue: 20/03/2022
					Sheet: 13/27





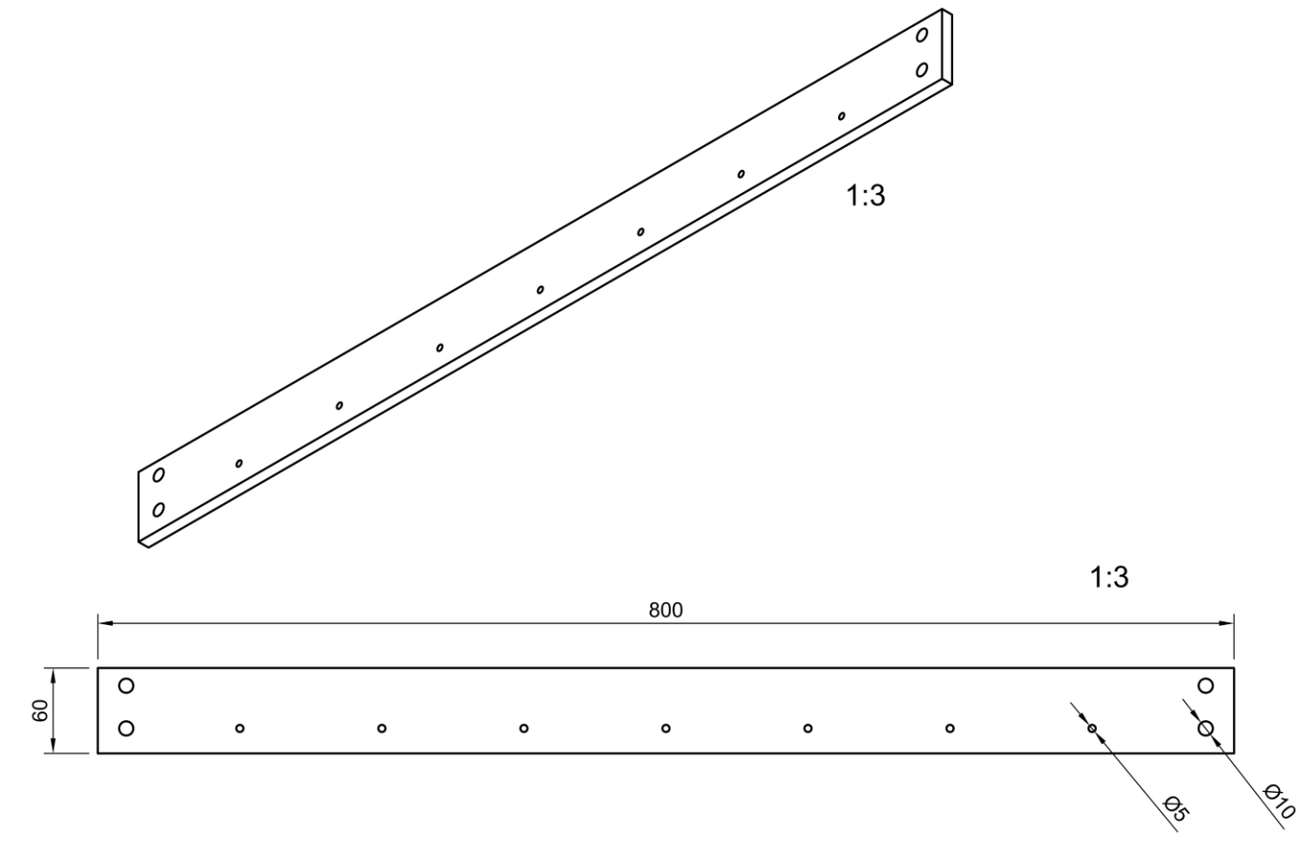
Dept.	Technical reference	Created by		Approved by	
ABA DT	---	Ayan Ali	20/03/2022	---	---
		Document type: (Section 1cm Cut)		Document status: Final Drawing	
RESEARCH		Title: Water Catcher Prototype Bottom Horizontal Bar SubAssembly		DWG No.: wc_final (v9)	
				Rev.: 0	Date of issue: 20/03/2022
					Sheet: 12/27



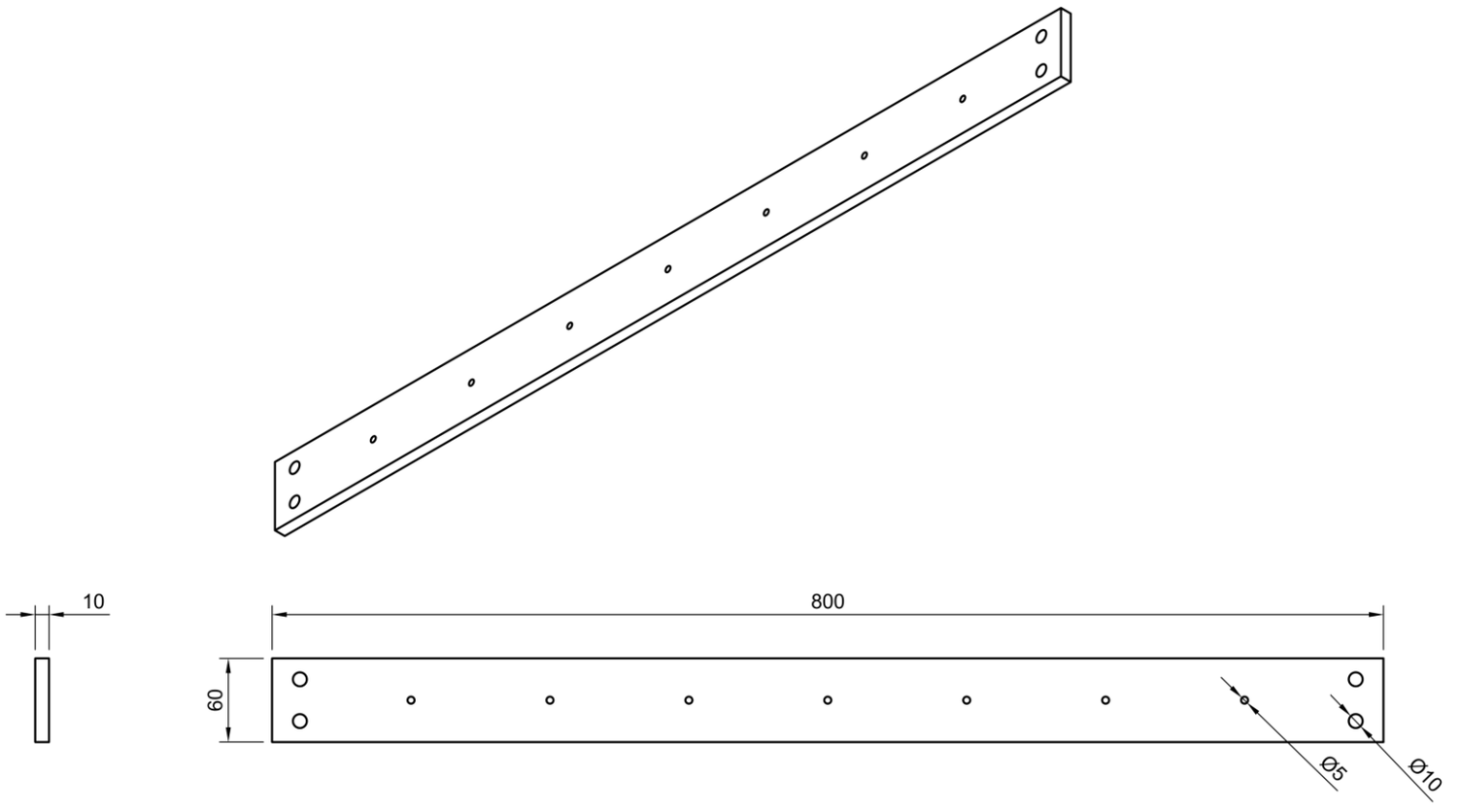
1:3

Dept. ABA DT	Technical reference ---	Created by Ayan Ali 20/03/2022	Approved by --- ---
AA RESEARCH		Document type Exploded	Document status Final Drawing
		Title Water Catcher Prototype Bottom Horizontal Bar SubAssembly	DWG No. wc_final (v9)
			Rev. 0 / Date of issue 20/03/2022 / Sheet 15/27

(52) Final Design Working Drawings (Continued)



Dept. ABA DT	Technical reference ---	Created by Ayan Ali 20/03/2022	Approved by --- ---
AA RESEARCH		Document type (Section No Cut)	Document status Final Drawing
		Title Water Catcher Prototype Bottom Horizontal Bar SubAssembly	DWG No. wc_final (v9)
			Rev. 0 / Date of issue 20/03/2022 / Sheet 14/27



Dept.	Technical reference	Created by	Approved by
ABA DT	---	Ayan Ali 20/03/2022	--- ---

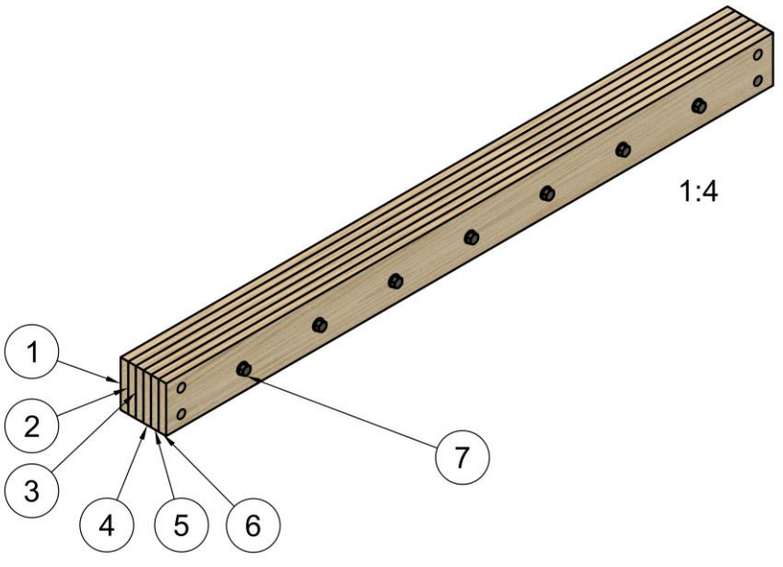
RESEARCH

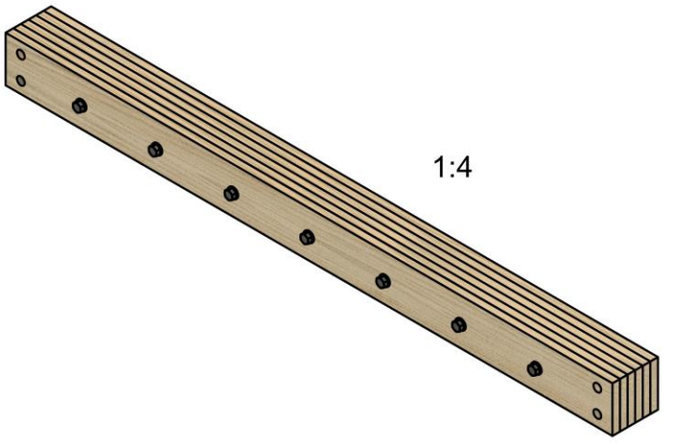
Document type	Document status
(Section)	Final Drawing

Title: Water Catcher Prototype
Top Horizontal Bar SubAssembly

DWG No.: wc_final (v9)

Rev.	Date of issue	Sheet
0	20/03/2022	17/27





Parts List			
Item	Qty	Part Number	Description
1	1	Section 6	
2	1	Section 5	
3	1	Section 4	
4	1	Section 3	
5	1	Section 2	
6	1	Section 1	
7	7	Hex M6 6cm Cut Screw	

There is only one section of plank in the bottom horizontal bar, this is:

(1) Section

Dept.	Technical reference	Created by	Approved by
ABA DT	---	Ayan Ali 20/03/2022	--- ---

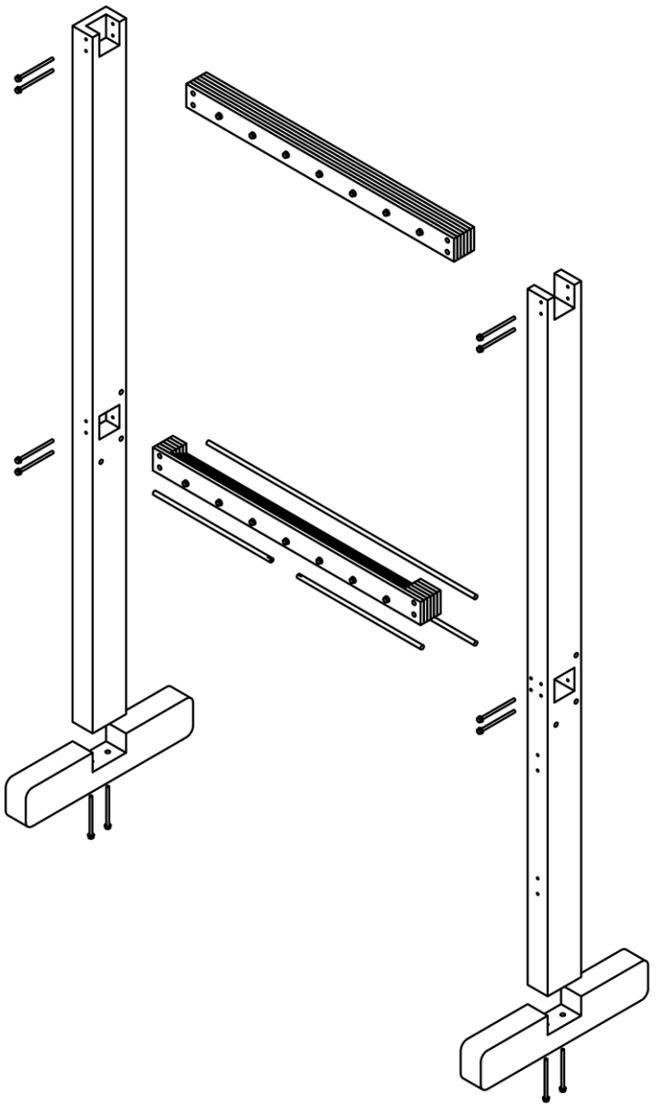
RESEARCH

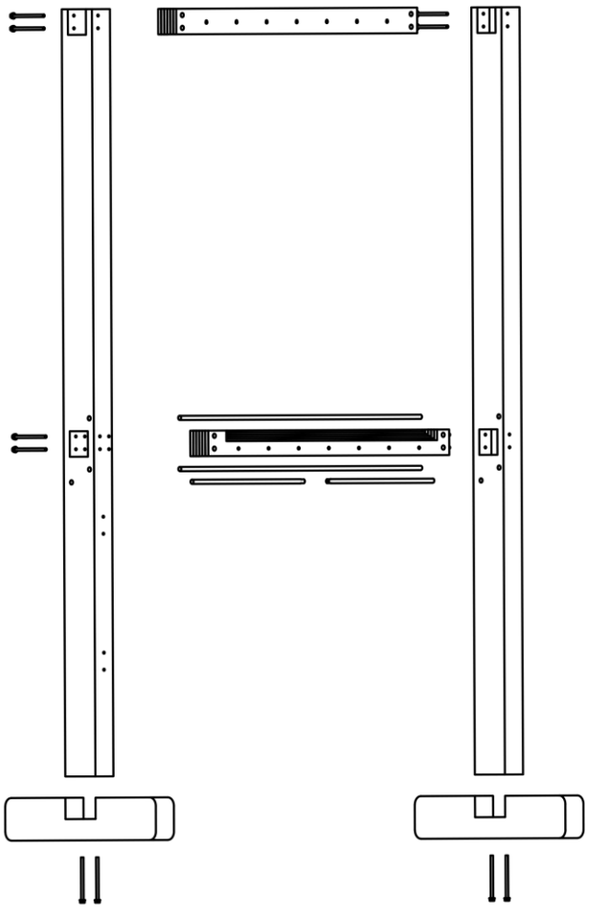
Document type	Document status
Isometric	Final Drawing

Title: Water Catcher Prototype
Top Horizontal Bar SubAssembly

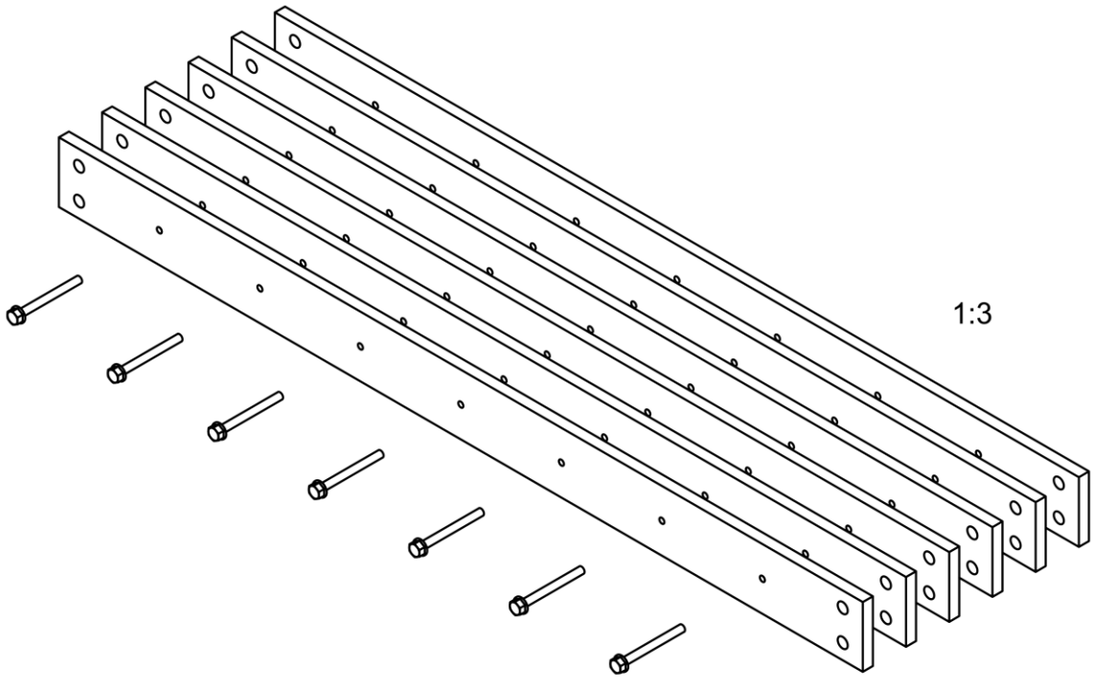
DWG No.: wc_final (v9)

Rev.	Date of issue	Sheet
0	20/03/2022	16/27

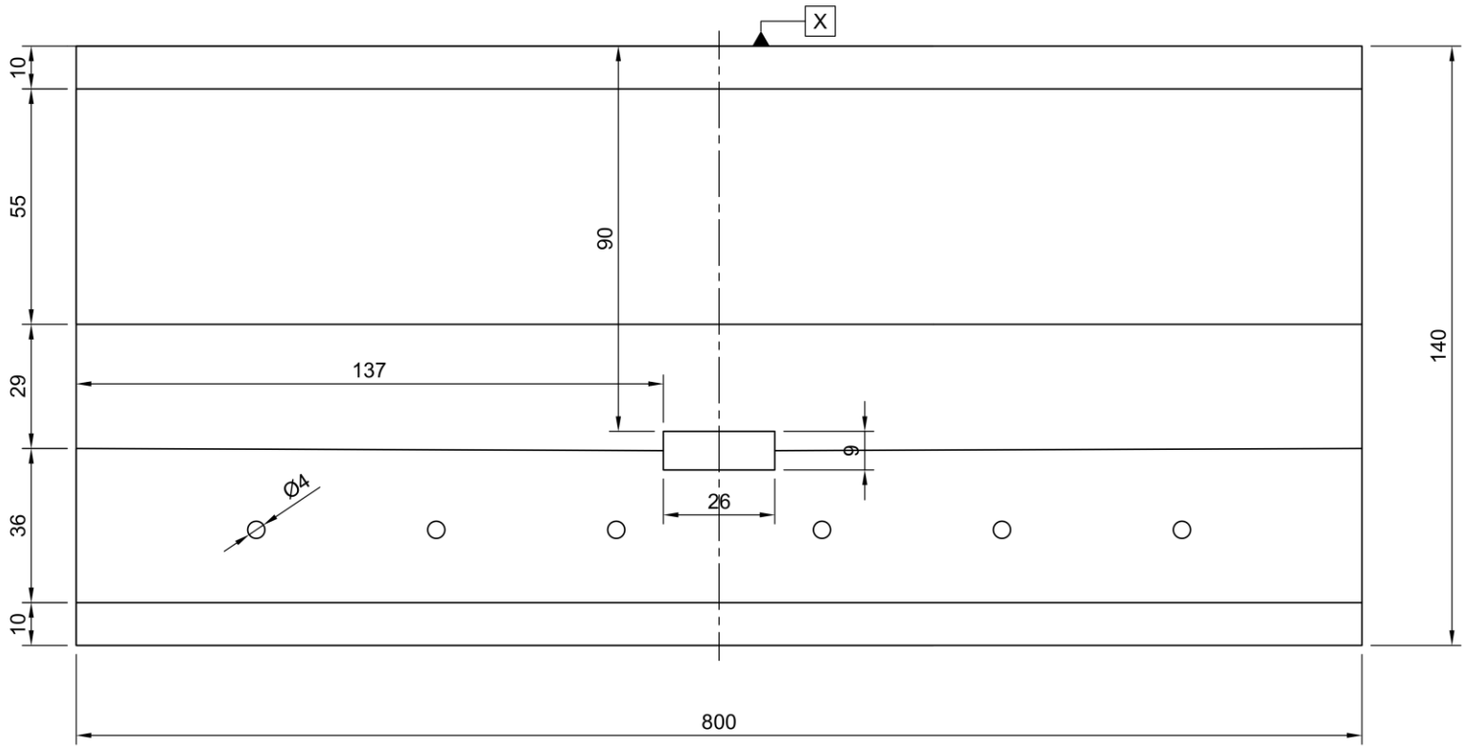




Dept.	Technical reference	Created by		Approved by
ABA DT	---	Ayan Ali	20/03/2022	--- ---
		Document type: Exploded		Document status: Final Drawing
AA RESEARCH		Title: Water Catcher Prototype Frame SubAssembly		DWG No.: wc_final (v9)
			Rev.: 0	Date of issue: 20/03/2022
				Sheet: 19/27



Dept.	Technical reference	Created by		Approved by
ABA DT	---	Ayan Ali	20/03/2022	--- ---
		Document type: Exploded		Document status: Final Drawing
AA RESEARCH		Title: Water Catcher Prototype Top Horizontal Bar SubAssembly		DWG No.: wc_final (v9)
			Rev.: 0	Date of issue: 20/03/2022
				Sheet: 18/27



This piece is made using plastic tarp and has the following holes cut, the square hole is for the funnel and the funnel is glued onto the plastic tarp using super glue, and the holes are where bolts will pass through mounting the piece securely on one end, the other end marked X will be curved arounnd the woodne dowel and stitched accordingly to make a sort of sleeve.

Dept.	Technical reference	Created by	Approved by
ABA DT	---	Ayan Ali 20/03/2022	--- ---
		Document type: (Tarp)	Document status: Final Drawing
RESEARCH		Title: Water Catcher Prototype Tarp SubAssembly	DWG No.: wc_final (v9)
			Rev. 0 / Date of issue 20/03/2022 / Sheet 21/27

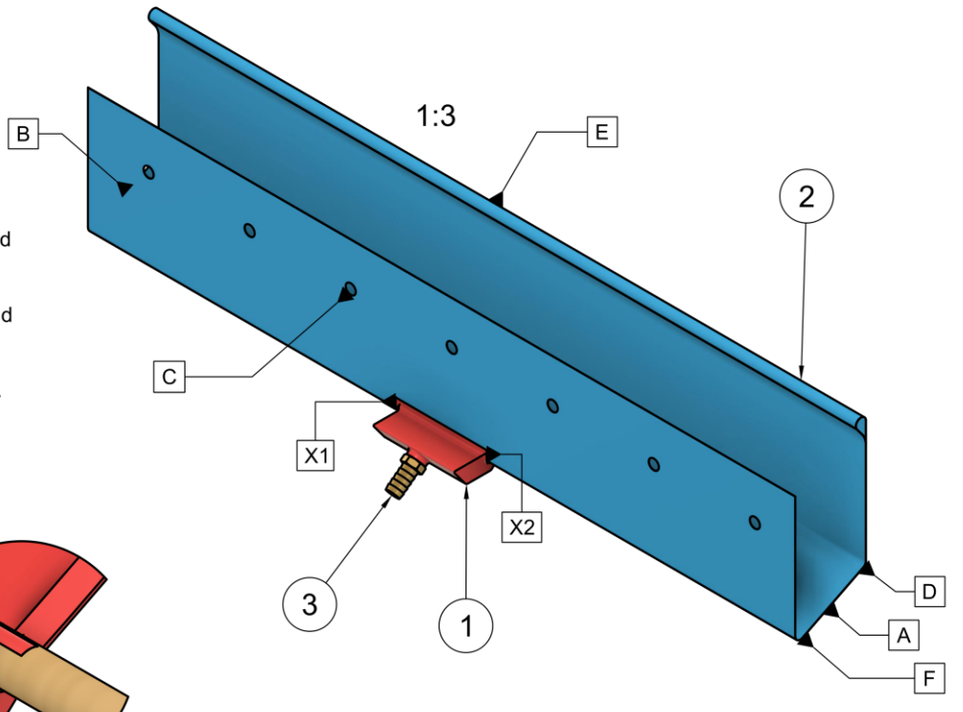
(55) Final Design Working Drawings (Continued)

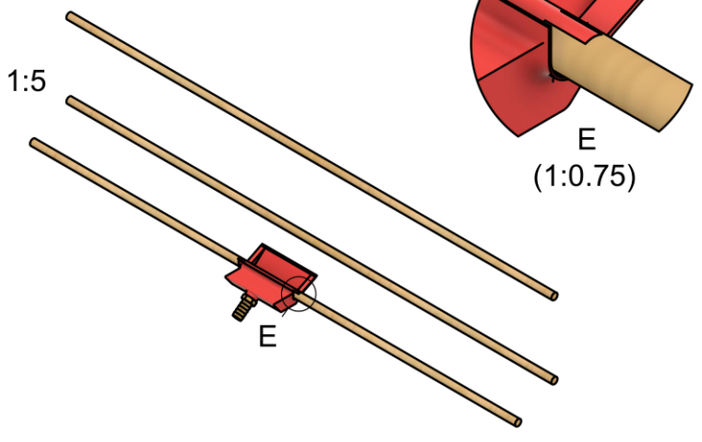
The blue tarp here is made from tarpaulin fabric, although it cannot hold water for more than 2-3 hours it is water resistant meaning none can get through, and it is very light meaning package weight is reduced. This means it is the perfect fabric for acting as a sort of large funnel that will guide the water into the red plastic funnel so that it can be collected.

The tarp will have 5 bend, and 3 stitch lines, with extra fabric being folded and stitched on each side to prevent run off on either side (not modled in the isometric for simplicity, but marked with A and B).

The red plastic funnel will slot into the split dowel at point X1 and X2, also shown in the detail view of E.

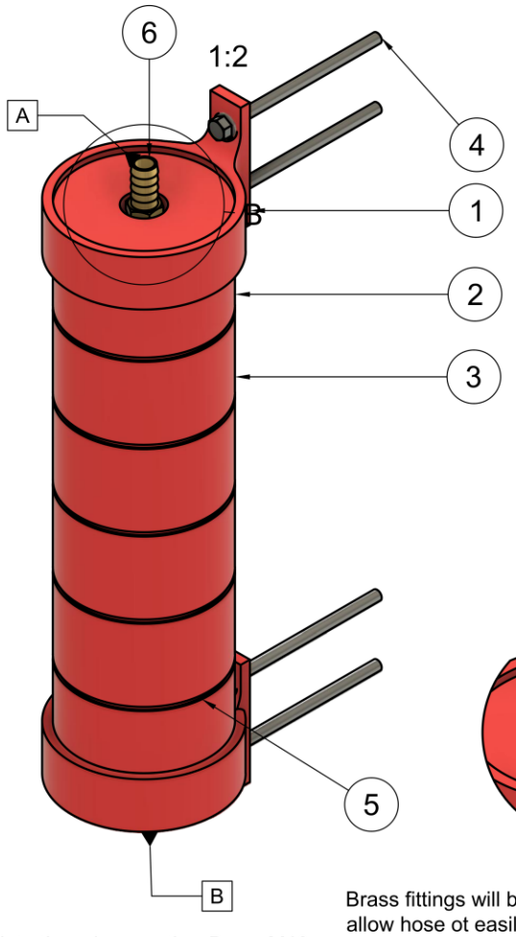
The tarp will bend around the three dowels at point F, D, and E. It will be bolted to the Bottom Horizontal Bar through the holes at C, the same bolts are also used to clamp the net into the Bottom Horizonta Bar (shown later), this is done to prevent excess screws and thus reduce cost.





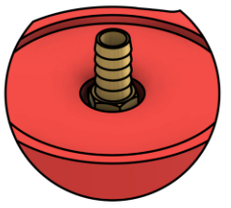
Parts List			
Item	Qty	Part Name	Description
1	1	Funnel	
2	1	Tarpaulin	
3	1	Brass M10 12mm Hose Fitting	

Dept.	Technical reference	Created by	Approved by
ABA DT	---	Ayan Ali 20/03/2022	--- ---
		Document type: Isometric	Document status: Final Drawing
RESEARCH		Title: Water Catcher Prototype Tarp SubAssembly	DWG No.: wc_final (v9)
			Rev. 0 / Date of issue 20/03/2022 / Sheet 20/27



Note there is a another Brass M10 12mm Hose Fitting underneath

B (1:1.5)



Brass fittings will be used on the top and bottom to allow hose ot easily be removed and attatched. Hose will go from the Red funnel A, and then from B to a water tank which is at a lower level so that there is no need for any pumps.

While having shorter Hex M6 Cut screws would make more sense, it does not greatly increase cost by having such large bolts as these bolts are also used elsewhere. I wanted to keep the types of components in this prototype as small as possible so we are using longer bolts so that the whole design only includes two types of bolts.

The bolts also pass straight through the wood to prevent and splitting in the wood, as if the bolt was only partially in it would split.

(1) Hex M6 10cm Cut Screw
(2) Hex M6 6cm Cut Screw

The filter is a passive filter that works by pulling contaminated water through varous layers of stone, charcoal, sand, etc. Each layer gets progressively fine until clean dirnking water is at the bottom. Water enters through A and exits through B. Each of the 6 sections will have a cloth covering on the top an bottom of each layerr. This will prevent material from falling deeper into the filter as the water flows through. On the bottom of the final layer (Filter cap Bottom) there will be a fine metal mesh to prevent any final particulate from continuing through into the water.

The filter structure will be 3D printed for the prototype, but if produced it will be injection moded to reduce costs.

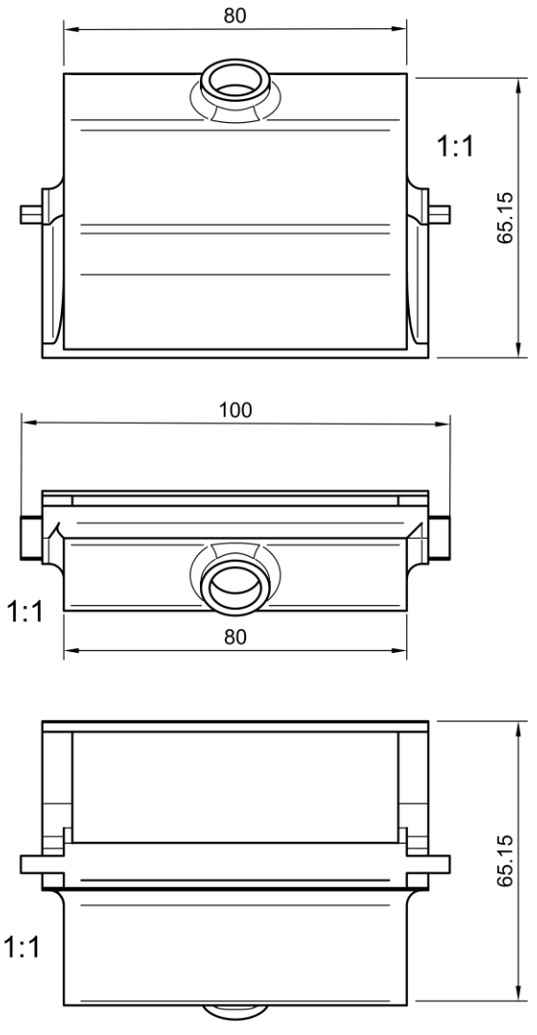
Item	Qty	Part Name	Description
6	2	Brass M10 12mm Hose Fitting	
5	1	Filter Cap Botom	
4	4	Hex M6 10cm Cut Screw	
3	4	Filter Section	
2	1	Filter Cap Top	
1	2	Filter Holder	

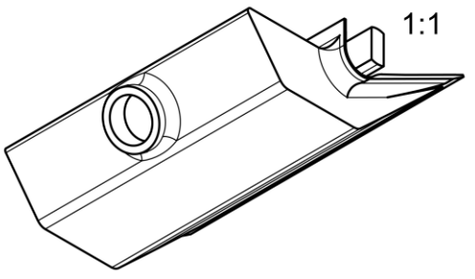
Parts List

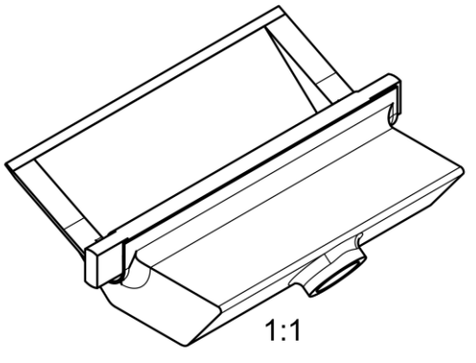
Dept. ABA DT	Technical reference ---	Created by Ayan Ali 20/03/2022	Approved by --- ---
AA RESEARCH		Document type Isometric	Document status Final Drawing
		Title Water Catcher Prototype Filter SubAssembly	DWG No. wc_final (v9)
			Rev. 0 / Date of issue 20/03/2022 / Sheet 23/27

(56) Final Design Working Drawings (Continued)

In the final product this will will be injection molded instead of 3D printed to greatly reduce costs of the product.







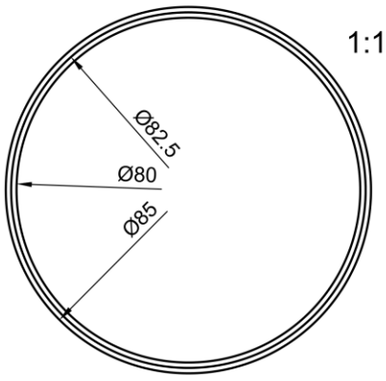
Specfic measurements are not required as this part is 3D Printed

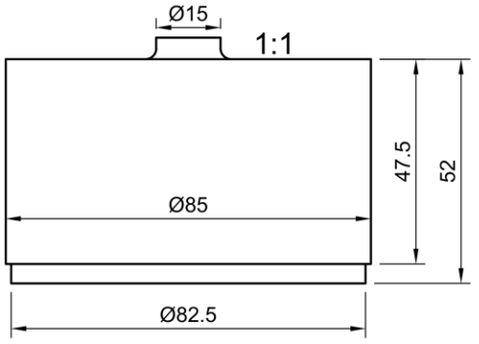
Dept. ABA DT	Technical reference ---	Created by Ayan Ali 20/03/2022	Approved by --- ---
AA RESEARCH		Document type (Funnel)	Document status Final Drawing
		Title Water Catcher Prototype Tarp SubAssembly	DWG No. wc_final (v9)
			Rev. 0 / Date of issue 20/03/2022 / Sheet 22/27

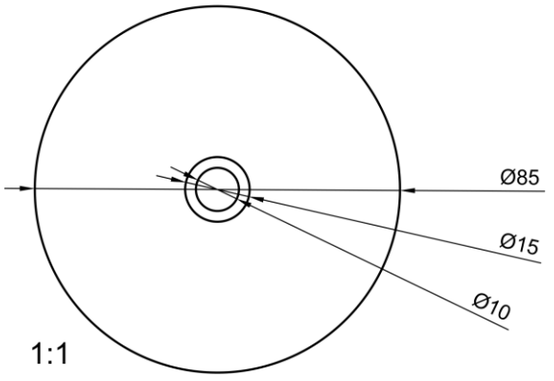
(57) Final Design Working Drawings (Continued)

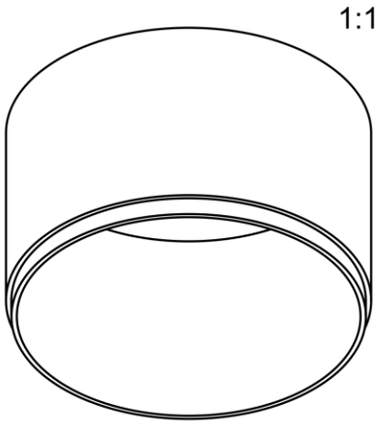
In the final product this will will be injection molded instead of 3D printed to greatly reduce costs of the product.

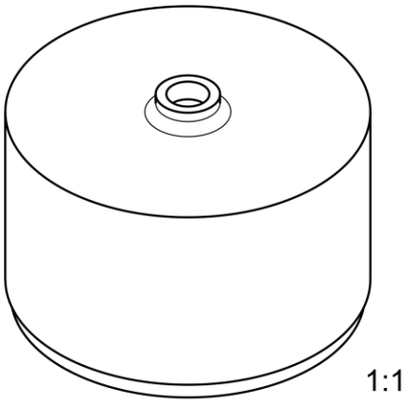
As we can see here each section has ledges on the top and bottom so that the filter easily slots together and the two Filter holders will compress all of these together. Each section will also have a rubber gasket applied to prevent leakages.





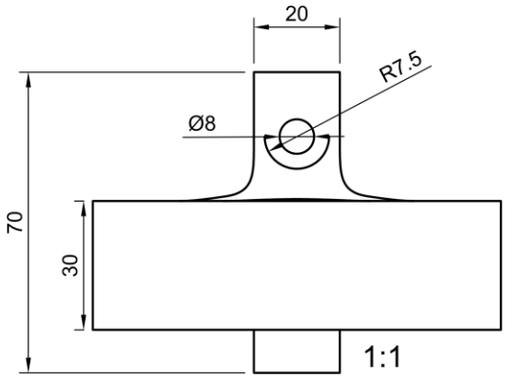


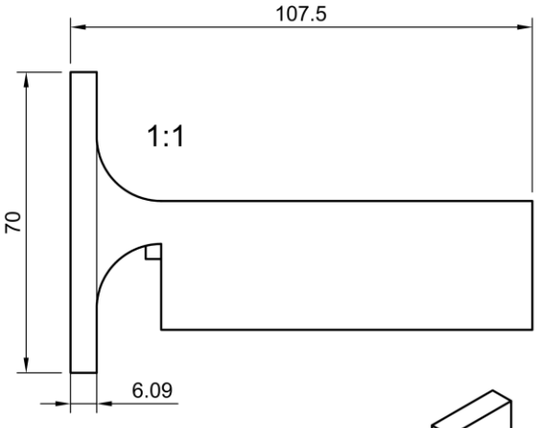


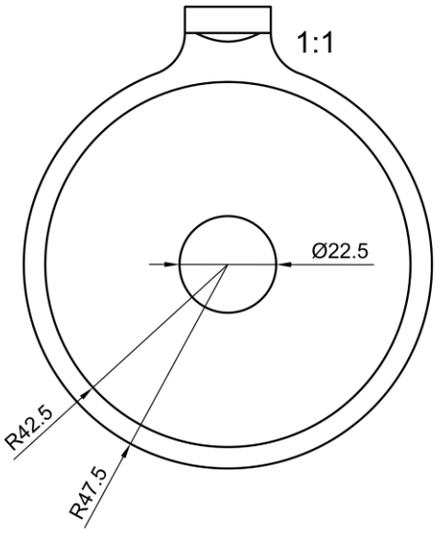


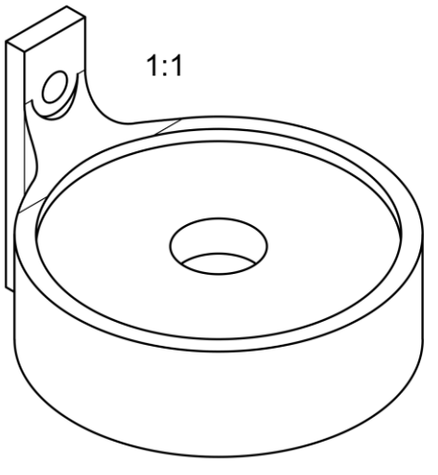
Specfic measurements are not required as this part is 3D Printed

Dept.	Technical reference	Created by		Approved by	
ABA DT	---	Ayan Ali	20/03/2022	---	---
		Document type: (Filter Cap)		Document status: Final Drawing	
AA RESEARCH		Title: Water Catcher Prototype Filter SubAssembly		DWG No.: wc_final (v9)	
				Rev.: 0	Date of issue: 20/03/2022
					Sheet: 25/27





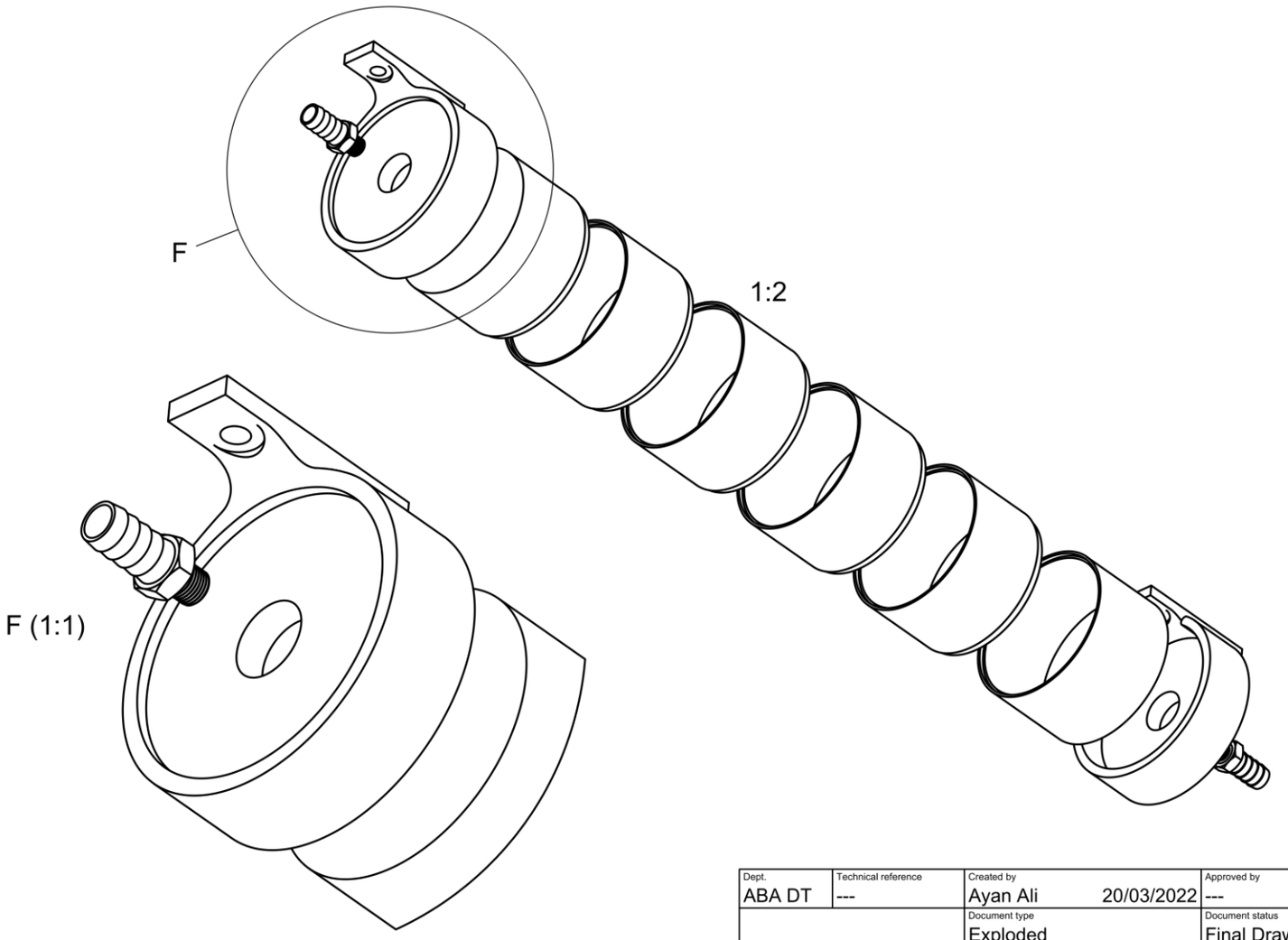




In the final product this will will be injection molded instead of 3D printed to greatly reduce costs of the product.

Specfic measurements are not required as this part is 3D Printed

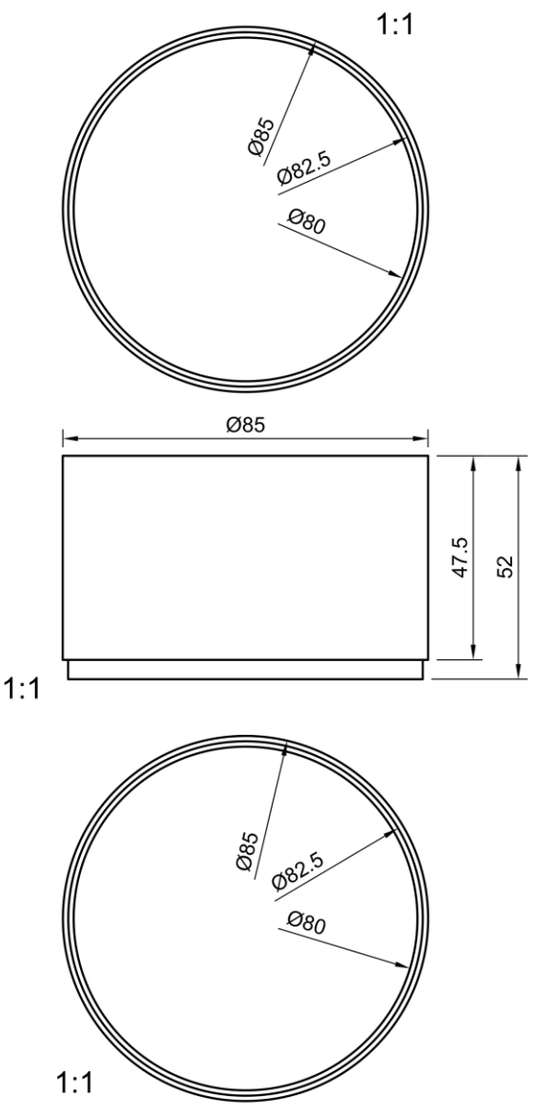
Dept.	Technical reference	Created by		Approved by	
ABA DT	---	Ayan Ali	20/03/2022	---	---
		Document type: (Filter Holder)		Document status: Final Drawing	
AA RESEARCH		Title: Water Catcher Prototype Filter SubAssembly		DWG No.: wc_final (v9)	
				Rev.: 0	Date of issue: 20/03/2022
					Sheet: 24/27



Note that the Brass Fitting does not fit onto the filter holder, but actually screws into the filter cap below

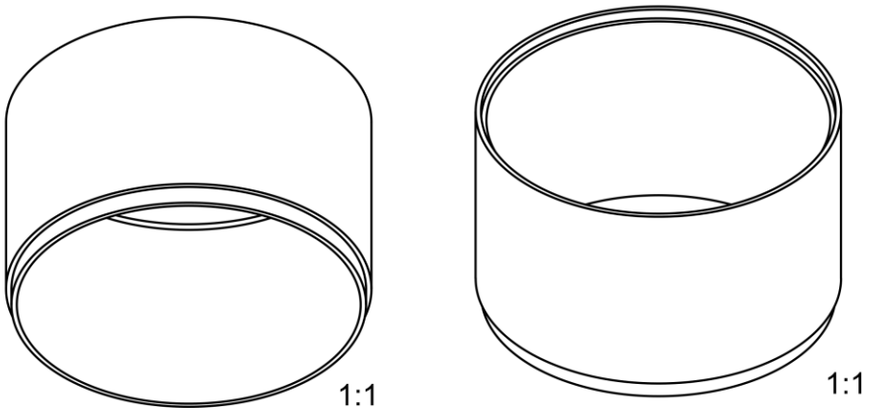
Dept.	Technical reference	Created by		Approved by	
ABA DT	---	Ayan Ali	20/03/2022	---	---
		Document type: Exploded		Document status: Final Drawing	
AA RESEARCH		Title: Water Catcher Prototype Filter SubAssembly		DWG No.: wc_final (v9)	
				Rev.: 0	Date of issue: 20/03/2022
					Sheet: 27/27

(58) Final Design Working Drawings (Continued)



In the final product this will will be injection molded instead of 3D printed to greatly reduce costs of the product.

As we can see here each section has ledges on the top and bottom so that the filter easily slots together and the two Filter holders will compress all of these together. Each section will also have a rubber gasket applied to prevent leakages.



Specfic measurements are not required as this part is 3D Printed

Dept.	Technical reference	Created by		Approved by	
ABA DT	---	Ayan Ali	20/03/2022	---	---
		Document type: (Filter Section)		Document status: Final Drawing	
AA RESEARCH		Title: Water Catcher Prototype Filter SubAssembly		DWG No.: wc_final (v9)	
				Rev.: 0	Date of issue: 20/03/2022
					Sheet: 26/27

(59) Final Design Cutting List + BOM

Introduction:
In this section, I plan to detail the components required for the assembly in a bill of materials, the wood sizes that need to be cut that will be needed for the water catcher.

Bill of Materials

Item Name	Qty.
120mm M5 Hex Bolt	26
M5 Hex Nut	26
M5 Washer	26
M10 1.2cm Brass Hose Fitting	2
~~Tarpaulin (Minimum 350mm by 900mm)~~	~~1~~
Acrylic Sheet (Minimum 350mm by 900mm)	1
1kg Spool of PLA 3.75mm 3D Printer Filament	1
~~10mm Diameter Wooden Dowel (Minimum 850mm length)~~	~~3~~
10mm Diameter Steel Rod (Minimum 850mm length)	3

* The tarpaulin has been replaced by the acrylic sheet, more detail in the manufacturing log

* The wooden dowels have been replaced by steel rods, more detail in the manufacturing log

Cutting List

Item Name	Material	Size	Qty.
Vertical Support	Pine	1800mm by 100mm by 60mm	2
Horizontal Beam Section	Pine	800mm by 60mm by 10mm	12
~~Cut Dowel Section (Open Type side)~~	~~Pine~~	~~340mm Length~~	~~1~~
~~Cut Dowel Section (Closed Type Side)~~	~~Pine~~	~~360mm Length~~	~~1~~
~~1cm Dia. Dowel~~	~~Pine~~	~~800mm Length~~	~~1~~
1cm Dia. Rod	Steel	800mm Length	3
Place Holder Support Legs	Pine	500mm by 100mm by 60mm	2
~~Tarpaulin Sheet~~	~~Tarpaulin~~	~~320mm by 800mm~~	~~1~~
Acrylic Sheet	Acrylic	320mm by 800mm	1

* The wooden dowels have been replaced by steel rods, the steel rods are difficult to cut notches into and so there are no need for cut rod sections and so the 3D printed funnel part can be modified instead, more detail in the manufacturing log

* The tarpaulin has been replaced by the acrylic sheet, more detail in the manufacturing log

Conclusion:
After completing this section, I now have an idea what components will be needed for the project to be executed successfully, and also have a starting point for the manufacturing section of this prototype where I will begin planeing, cutting, and sanding raw wood into suitable pieces for further refinement into the final components for the water catcher. A BOM will allow me to order parts in advance, so no time is wasted during manufacturing.

Moving Forward:
In the next section, I plan to detail the construction processes and tools required for the water catcher to be built successfully allowing me to plan out a efficient order of operations due to the limited time available as a result of continuous lockdowns.

(60) Final Design Materials Justification

Introduction:
In this section of the NEA, I plan to identify the advantages and disadvantages of the materials I am using in the final design, and those materials that I would have used if available, and if we had the facilities to manipulate them.

Conclusion:
After completing this page, I have identified the strengths and weaknesses of the major materials I will be able to decide which components will require finishing and which one will not. The weaknesses of these materials could perhaps be the topic of further possible research in the evaluation.

Moving Forward:
In the next section, I plan to detail the construction processes and tools required for the water catcher to be built successfully allowing me to plan out a efficient order of operations due to the limited time available as a result of continuous lockdowns.

Material	Advantages	Disadvantages	Overall Opinion
Aluminum	Strong- high torsional, tensile, and compressive strength Non-ferrous- cannot rust in rain or snow, retaining structural integrity Lightweight- makes it easier to carry to remote areas, and reduces carbon footprint when being shipped	Expensive- makes the product cost more Soft- can be scratched, and dented	Overall for the frame this would have been a very suitable material, as it is lightweight so easy to carry into remote areas. It is non-ferrous and so does not rust in the harsh wet conditions, and thus does not require surface finishing keeping costs down.
Steel	Strong- high torsional, tensile, and compressive strength Hard- difficult to scratch and dent Rigid- very rigid meaning it does not bend easily	Expensive- makes the product cost more Heavy- difficult to carry to remote areas, increased carbon footprint Ferrous- can rust in rain or in snow reducing structural integrity	Although not the best case scenario steel is still a suitable materials as long as it has been varnished or painted to prevent rust. It however is heavier than aluminum, but since the design does not contain much steel so the weight difference should not be as large.
Pine	Cheap- relatively cheap compared to metals, thus reducing overall product cost Rot Resistant- does not rot easily, so structural integrity is retained Resists Shrinking and Swelling- can handle snow and rain without changing shape Lightweight- makes it easier to carry to remote areas, and reduces carbon footprint when being shipped Sustainable- Grows quickly	Soft- can be scratched, and dented Slightly Flexible- this can be a problem in high winds as it may change the shape of the product permanently reducing its effectiveness.	Pine is not the best case scenario but it is a very solid candidate for being a compromise for the aluminum frame. It is lightweight and so can be transported to remote places easily, it is rot resistant so a varnish is not entirely needed but a varnish would be the guarantee the prototype would last. It is also very suitable as it grows very quickly compared to other woods, and also resists shrinking and swelling so the frame does not become lose.
Acrylic	UV Resistant- this means that it does not degrade easily in sunlight, and also can thus handle high temperatures of up to 160 degrees C without softening. Cheap- relatively cheap compared to materials, thus reducing overall product cost Easily Reusable- this means that acrylic does not become ‘exhausted’ after too many recycling cycles	Toxic- Acrylic is highly toxic during the production process and released toxic fumes during production which can go onto damage the environment. Toxic when burning- Since acrylic does not easily biodegrade, if burned in an incinerator (as ex. the prototype was not sent to the correct recycling center) then highly toxic gases would be released when burning the acrylic.	This is a suitable material as it is long lasting and hardwearing. Moreover it is cheap and can be easily recycled. However this material is not a perfect fit as it is highly toxic and bad for the environment during production.
PLA	Compostable- Since PLA is made from plant matter it can easily be composted in an industrial composter. Eco-friendly- PLA is not made from hydrocarbons but rather from plant matter which when growing absorbed CO_2 from the atmosphere, and it also uses less energy to make the plastic as energy hungry fractionation is not involved. Cheap- relatively cheap compared to plastics, thus reducing overall product cost	Low melting point- PLA starts to soften of upwards of 65 degrees C, this can be a problem as some days it may get hot enough to weaken the plastic over the years. Brittle- PLA is quite brittle.	PLA is not a suitable material was only used as the 3D printer that will be used in the manufacturing process can only print in PLA safely. It is not suitable as it softens at a very low temperature and is very brittle and so breaks easily during assembly or shipping. In the real end product this should be replaced with HDPE that will be injection molded.
Tarpaulin	Waterproofing capability- Tarpaulin is a fabric that has been coated with a plastic layer such as PVC, this makes the fabric able to prevent water from seeping through. Lightweight- makes it easier to carry to remote areas, and reduces carbon footprint when being shipped	Contains PVC- PVC is highly toxic and if burned again releases dangerous gases to the environment.	This material is suitable as it has all the required waterproofing capabilities of other plastics whilst being very lightweight and able to fold into a small package.

Due to the availably of materials in the school workshop, and no capacity to weld, shape, or cut aluminum, some materials have been substituted by others, this has already been mentioned in the development section where a material’s decision was made between the wood and aluminum frame.

However even if the material’s have been replaced I have still outlined the advantages and disadvantages of the omitted materials. Instead of using aluminum framing we have instead used Pine and a little bit of steel. We have also replaced the tarpaulin with acrylic instead. (More detail in the manufacturing log)

(61) Final Design Construction Processes + Tools Required

Introduction:
In this section, I plan to detail the construction processes + tools that will be used to make and assemble the final water catcher prototype. This will thus allow me to create an efficient order of operations to allow me to utilize my limited manufacturing time and thus produce a finished prototype.

Construction Processes Involved in Manufacturing

Process	Where it is used
Planeing wood using a Planer	Preparing raw wood for cutting list
Cutting Wood using a Mitre saw	Cutting raw wood down to size for cutting list
Cutting Wood using a Hand Saw	Cutting out grooves for easy chiselling in the vertical support pieces
Cutting wood using Coping Saw	Cutting out hard to reach places in the vertical support pieces
Cutting Steel using Auto-hacksaw	Cutting the steel rods down to size for cutting list
Buffing Steel using Cordless Drill and Iron-wool attachment	Making the steel rods rust-free
Sanding wood using orbital sander	Finishing final structure and getting ready for varnishing
Varnishing	Used to varnish the wood frame to protect form the elements
Sanding wood manually using sanding paper and sanding blocks	Used to sand in hard-to-reach places
Chiselling Wood using chisels	Chiselling out the joints in the vertical support pieces
Pairing wood using chisels	Used to clean up joint sections to allow for tight friction fit joints.
Drilling holes using Cordless drill	Drilling holes in the horizontal bar sections
Drilling holes using Pillar drill	Drilling out holes in the vertical support beams for the rods, and for easy chiselling
Laser cutting Acrylic using laser cutter	Used to cut out holes and engrave lines for easy assembly of the "tarp section" funnel
Bending Acrylic using a line bender and heat gun	Used to bend plastic piece into the correct shape for final assembly
3D printing plastic parts in PLA using a 3D printer	Used to print the 8 piece for the filter assembly, and the complex funnel shape.
Routering out sections of wood	Used to make it easier to chisel out sections in the vertical support beams.

General Plan

No.	Step	Description	Approximate hours Required
1	Cut raw wood into correct sizes	Use cutting list to get the wood ready	5
2	Plane raw wood into correct thicknesses	Use cutting list to get the wood ready	4.5
3	Sand raw wood down to remove splitters	Used to get the wood ready for chiselling	2.5
4	Cut out joints in the vertical support beams	Chisel out the joints in the beams	7.5
5	Dry fit all joints	To double check that everything fits correctly	0.5
6	Drill out the holes in the vertical support beams and in the Horizontal bars	For installation of dowels in the vertical beams, and for screw drilling to in the horizontal sections	3
7	Clean up pieces through sanding to prepare for varnishing	Sand down harsh surfaces for smooth finish, and round edges slightly with hand sanding	6.5
8	Laser cut acrylic	Laser cut acrylic for the water catchment system	0.5
9	3D print out filter + funnel + clean-up pieces	3D print, clean-up, and sand pieces ready for assembly	1
10	Bend the acrylic	Bend the acrylic into the correct shape using a line bender	1.5
11	Dry fit all components + Plastic Weld the 3D printed funnel onto the acrylic	Used to check everything fits, and attach the 3D printed funnel to the acrylic piece.	1
~~12~~	~~Disassemble and varnish all wood pieces~~	This step has been skipped due to restricted manufacturing time due to a lockdown.	~~3~~
13	Reassemble catcher + Place net into the grooves	Place the net into the grooves and tension the nets	6
Total Hours Taken			~~42.5~~ 39.5

* The above hours are over-estimates so that there is ample time for complete assembly of the final prototype

Conclusion:
After completing this section, I have a good understanding of the tools and processes that are going to be used in the construction process and have outlined a general plan to follow during the manufacturing phase.

Moving Forward:
In the next section, I plan to design the assembly booklet for the water catcher and print, cut, staple, and refine the final assembly booklet ready for the final product. After this I plan to document the manufacturing process of the water catcher.

(62) Assembly Booklet Final Design Overview + Final Booklet Outcome

Introduction:
In this section, I plane to detail how the booklet was constructed, designed, and how it works. The assembly booklet will allow the user to be able to easily assemble the prototype in the field without much hassle.

Figure 18.1

Figure 18.2

Figure 18.3

Figure 18.4

Designing the booklet:
The booklet was simply designed in a word document, and the orthographic images (as shown in figure 11.4) were made using fusion 360's animation environment and then drawn in the drawing environment.

The booklet was heavily inspired by Ikea instruction manuals where knowing how to read English is not required thus making the assembly booklet suitable for all regions of the regardless of language barriers.

The booklet is split into four different sections as shown in figure 11.3:

(1) Main Blue Sleeve
(2) Part 1 (Frame Assembly)
(3) Part 2 (Tarp Assembly)
(4) Part 3 (Filter Assembly)

This has been done to reduce any confusion caused when assembling the different parts of the water catcher as the orthographic views to 'jump around' a lot.

Page numbers were also designed in on the bottom of the page, and the part number for each components was also mentioned on the bottom of the page as shown in figure 11.6.

Constructing the booklet:
The booklets where split into 4 parts and then printed using the Adobe Acrobat DC booklet printing section where the correct pages are printing on the correct faces of paper allowing a booklet to be made easily, thus removing the need of manually sorting the pages out.

The blue sleeve was printed with two blue papers, one for each face of the paper, thus making the sleeve slightly thicker that the booklet and giving rigidity to the sleeve. The two papers were simply laminated together using glue and were held using heavy books for pressure until the glue dried. Blue was used to differentiate from the rest of the three booklets and did not contribute to any increased printing costs as the same black ink was used on top of the paper.

For stapling the booklets together, the stapler we had available was not wide enough for the booklets to be easily stapled and so using a sewing needle holes were poked for "unstapled" staples to be put through and then bent on the other side by hand, this can be more easily seen in figure 11.5.

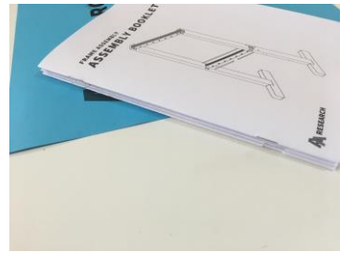


Figure 18.5

Figure 18.6

How does the booklet work?:
The sleeve of the booklet acts as a binder for all of the booklets inside and shows what the three booklets will end up making if followed. In each booklet the front cover gives the name of the assembly, then a picture of said assembly, and lastly what booklet number it is (M, P1, P2, P3). In each booklet the first section shows what parts will be required with names given for each. There are the same physical number of components shown and the same that will be needed in the assembly process, as ex. If 12 bolts are shown then 12 bolts will be needed, this physical counting removed the need for interpretation of numbers making it more "language friendly". The next pages show step by step how to assembly the product and finally the last step F shows the final assembly.

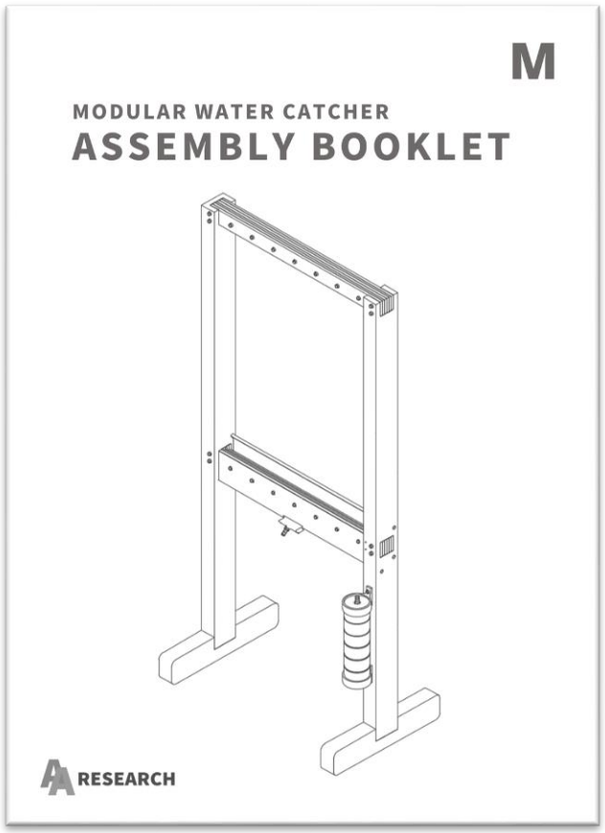
The assembly booklet for the frame assembly also contains a step 10A and 10B showing the two possible options for the assembly of the water catcher, 10A shows if the water catcher was only a single unit and thus only one net was used, and then step 10B shows another option for if there were multiple nets present and the water catcher was expanded to increase its total capacity with additional nets.

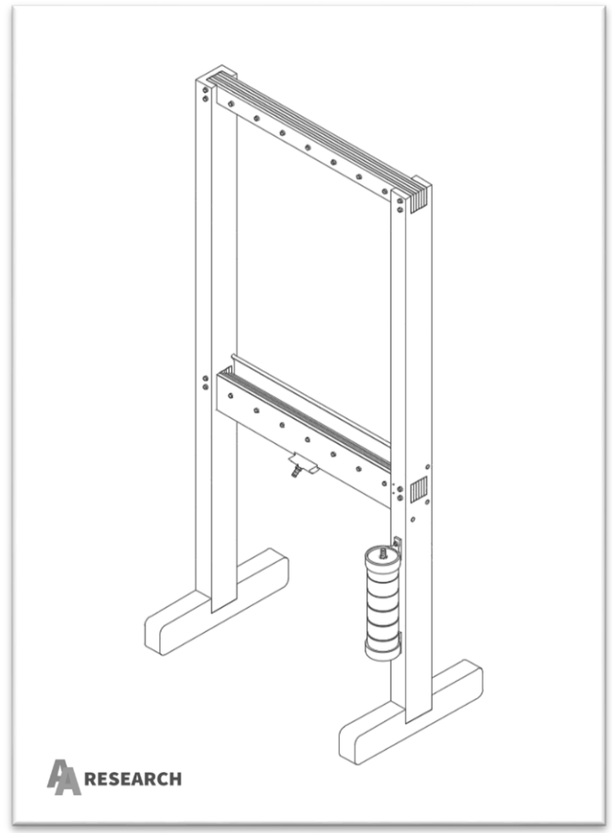
* The layout of the final booklet is shown on the next few pages

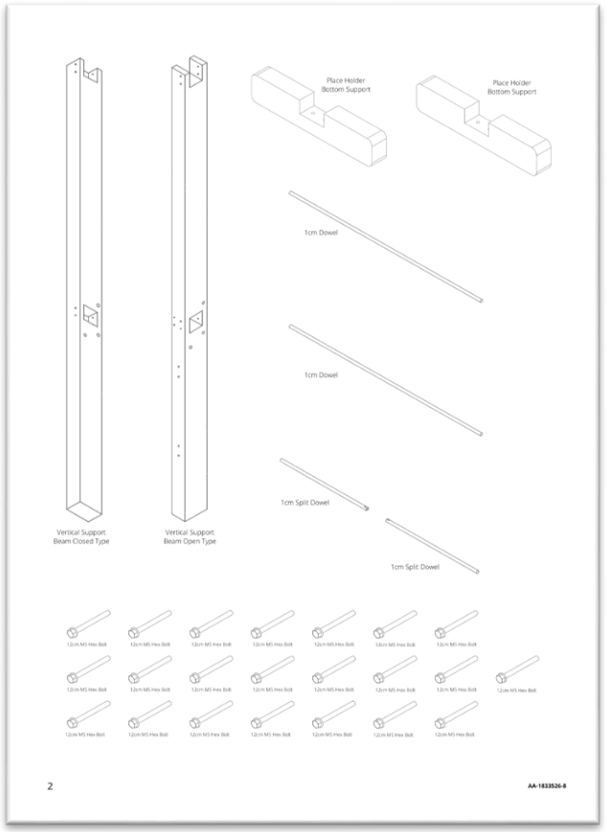
Conclusion:
After completing this section, I have completely finalized the assembly booklet part of the project and am one step closer to a final prototype of the water catcher.

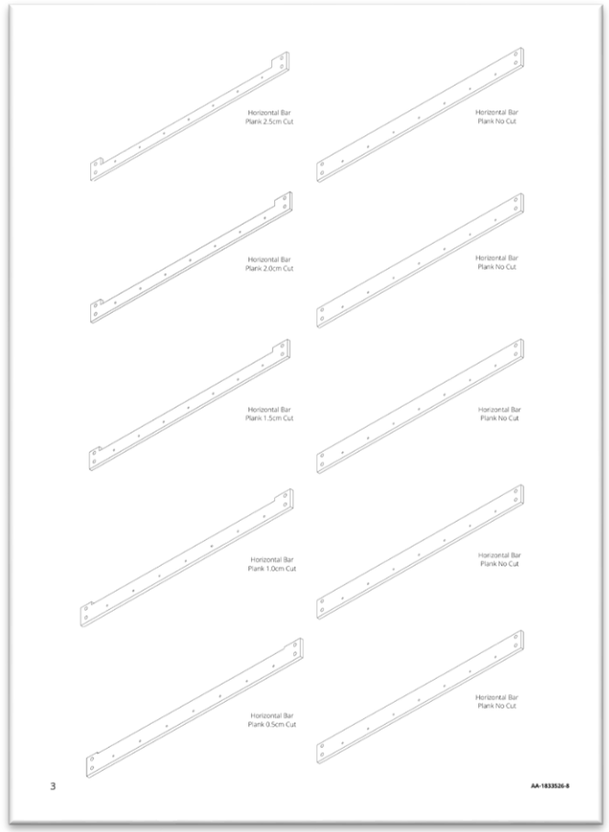
Moving Forward:
In the next section, I plan to provide a manufacturing log of the water catcher with safety precautions that I followed, tools used, process used, and a general description of the step.

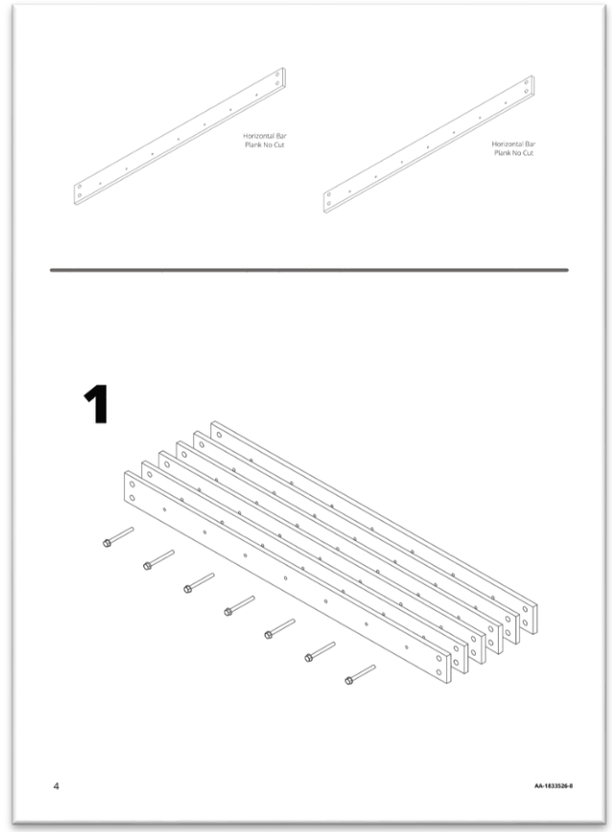
(63) Assembly Booklet Final Design Layout



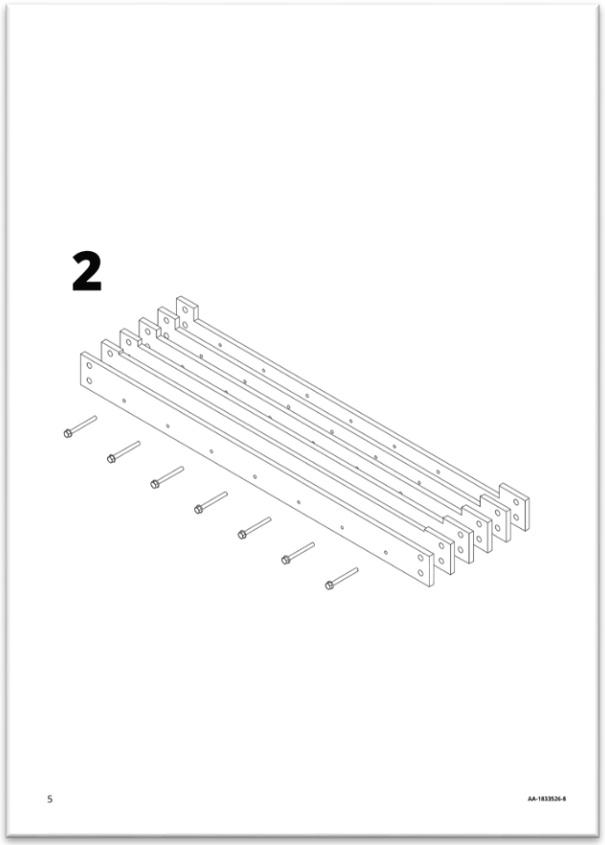


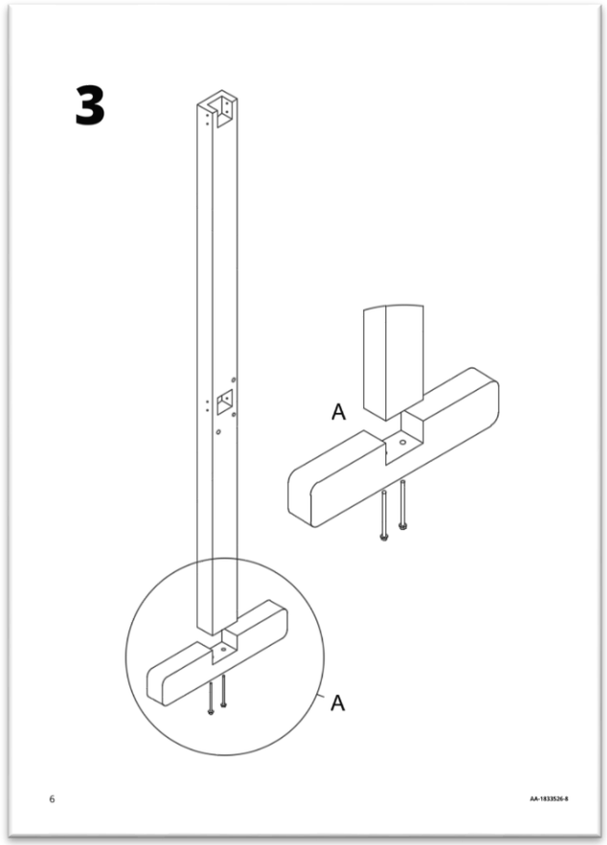


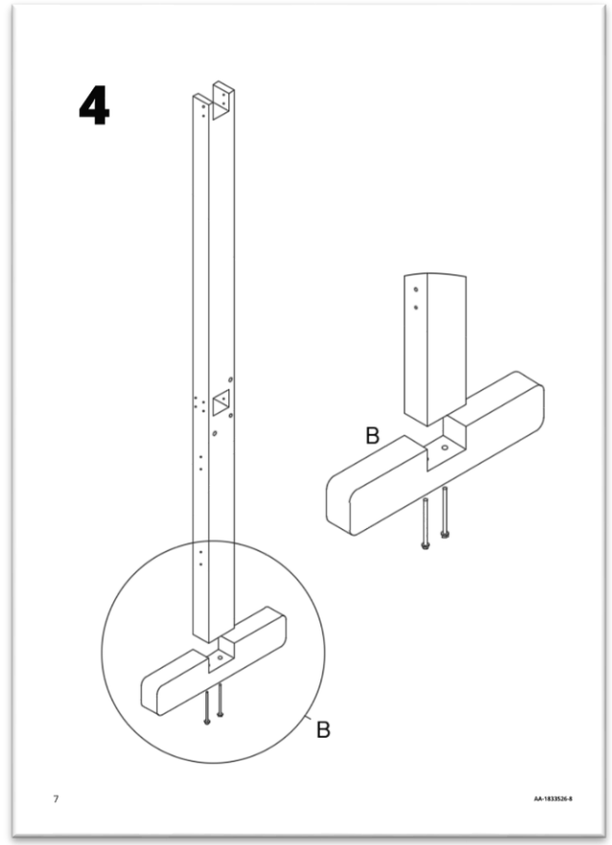


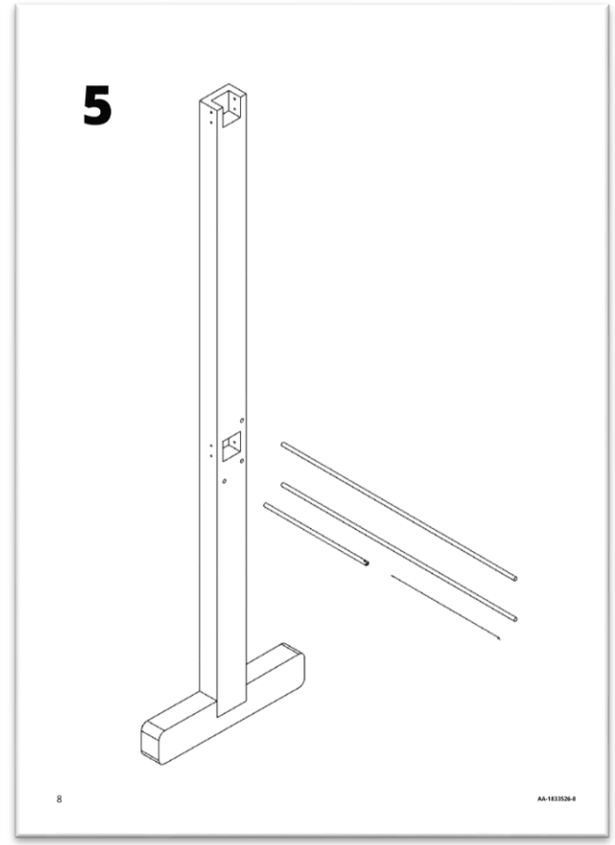


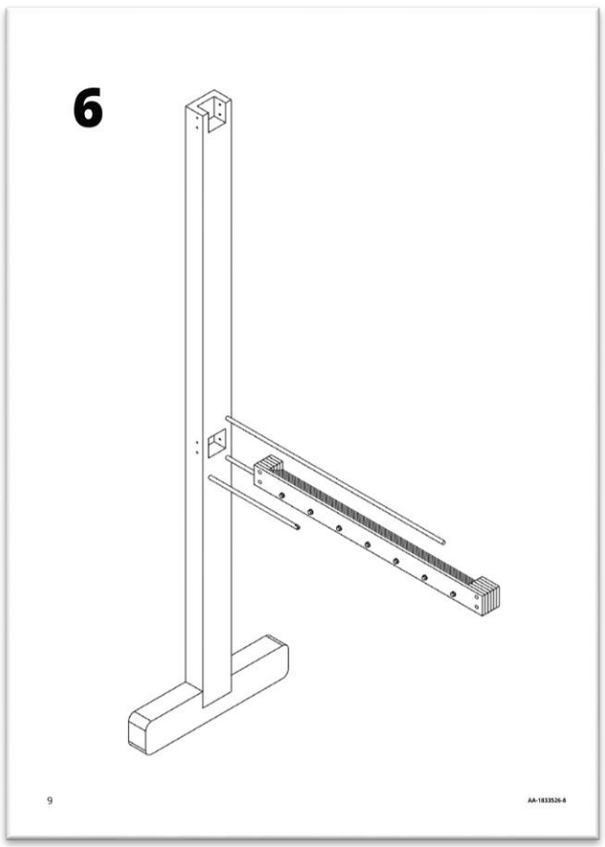
(64) Assembly Booklet Final Design Layout (Continued)

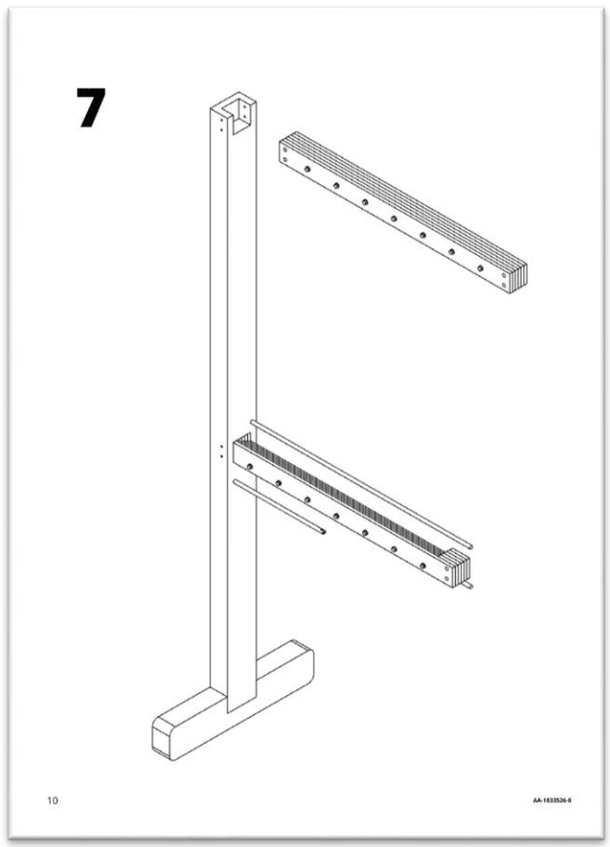


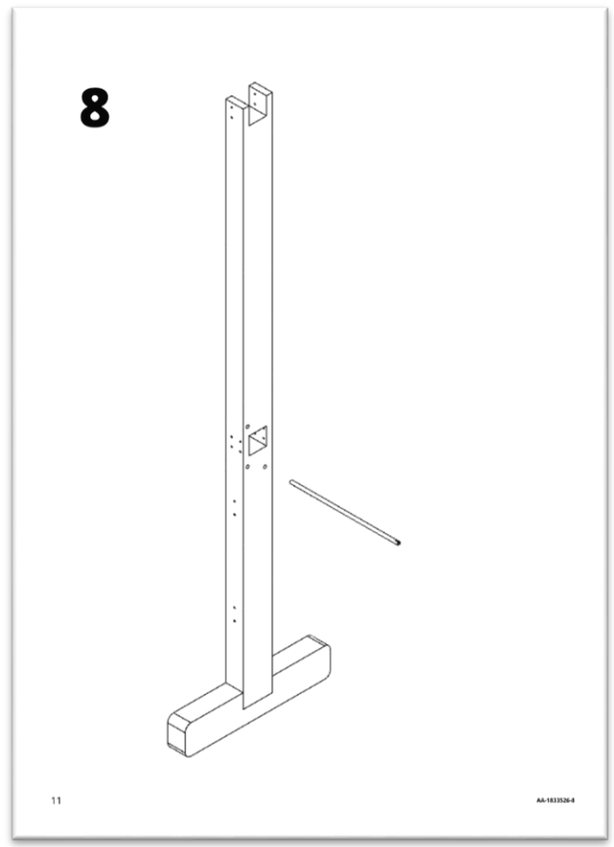


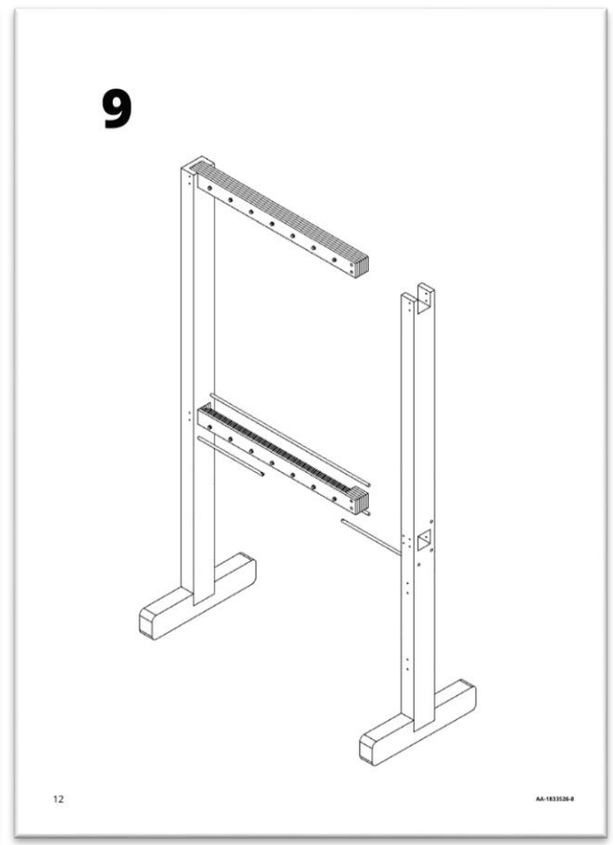




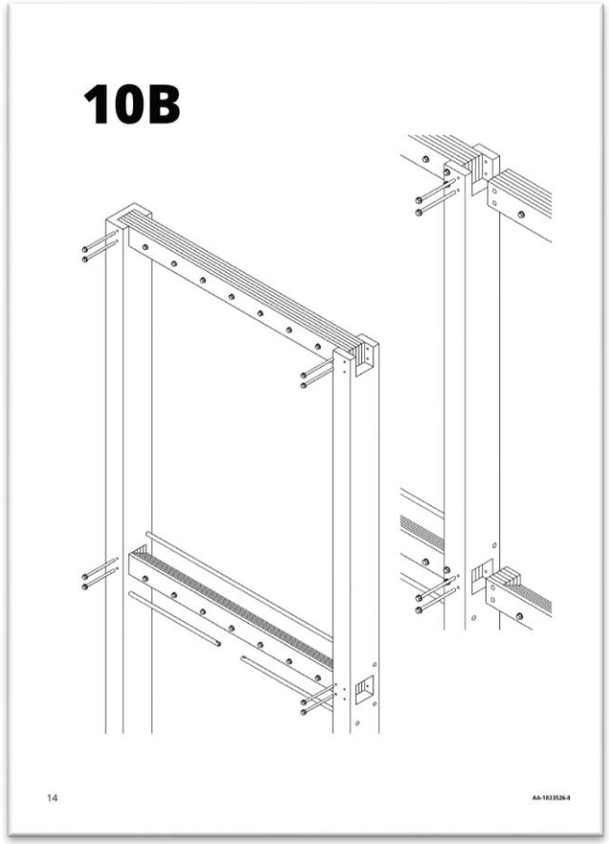


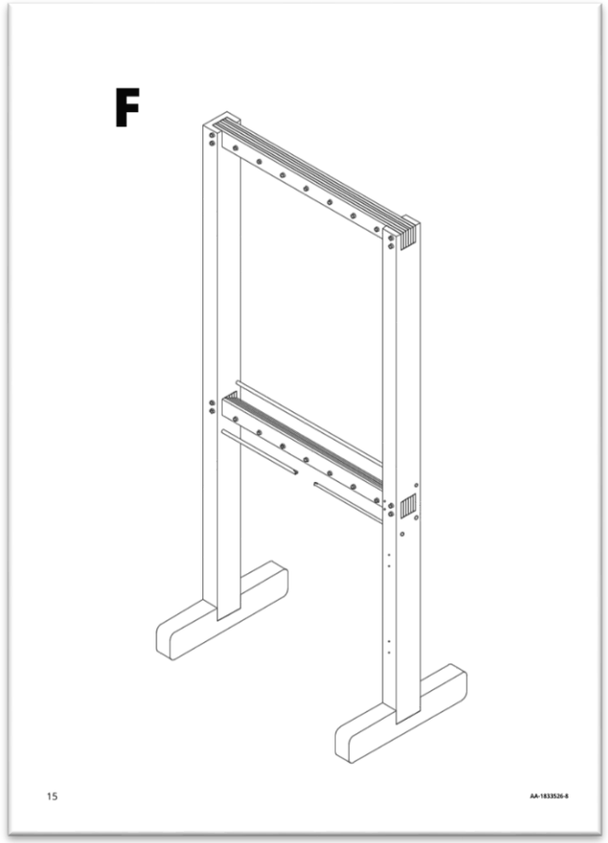


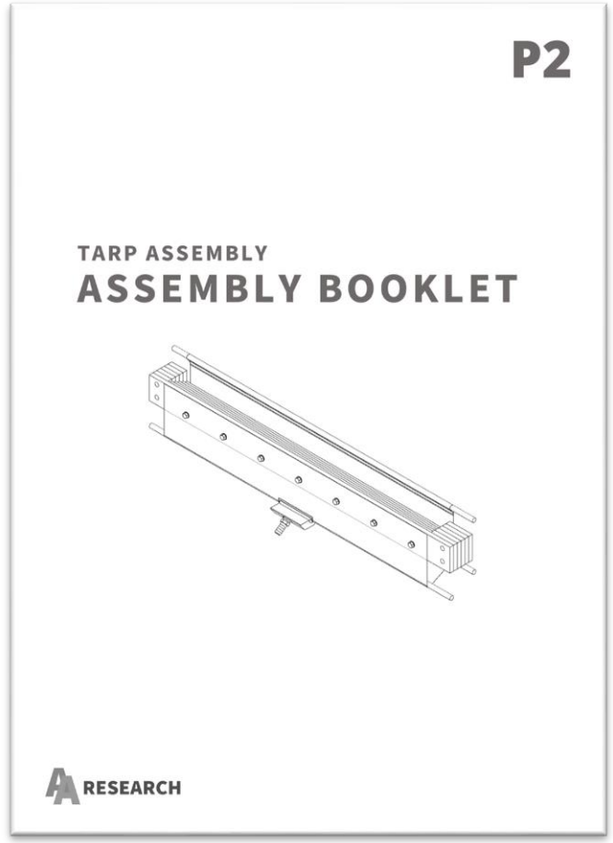


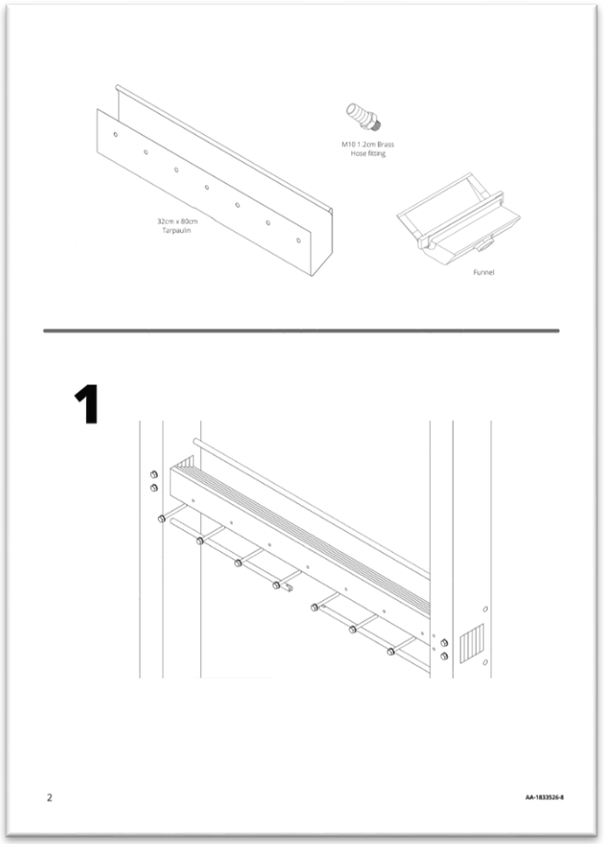


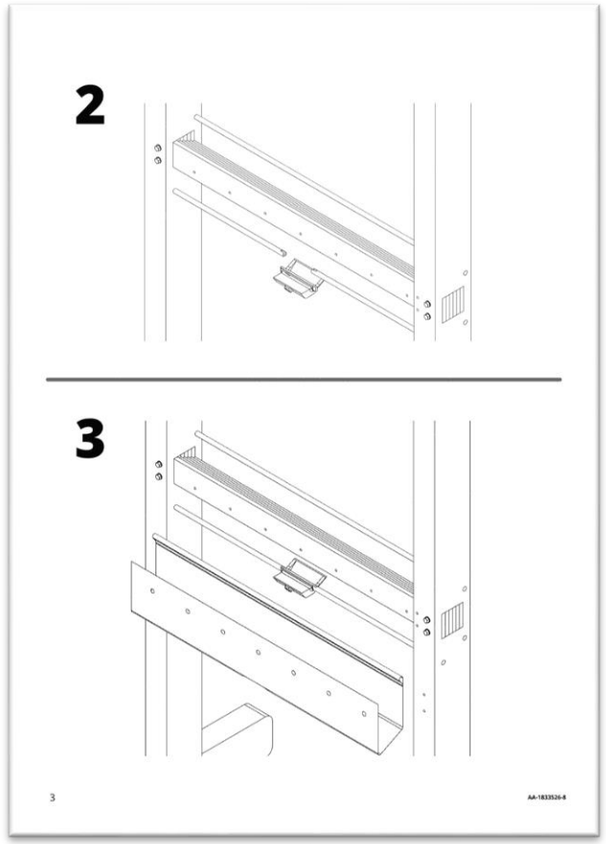
(65) Assembly Booklet Final Design Layout (Continued)

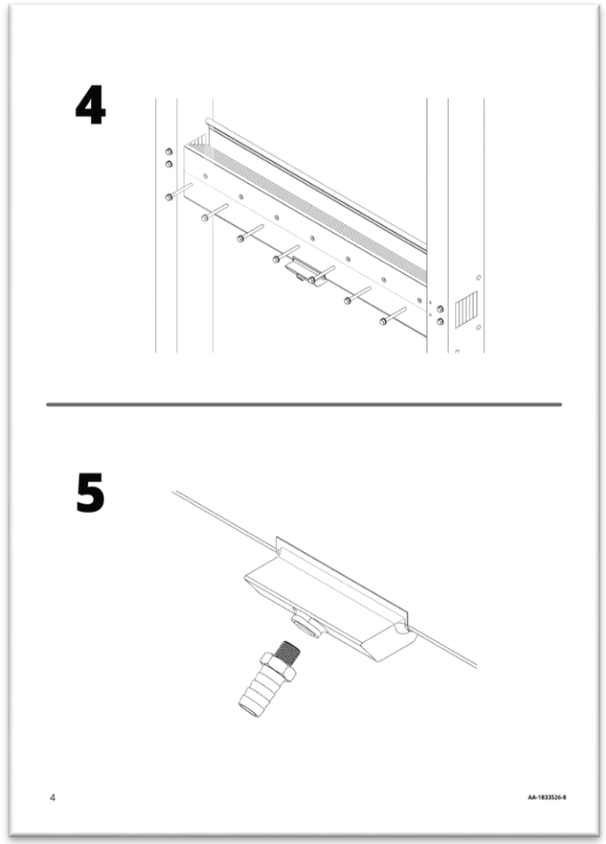


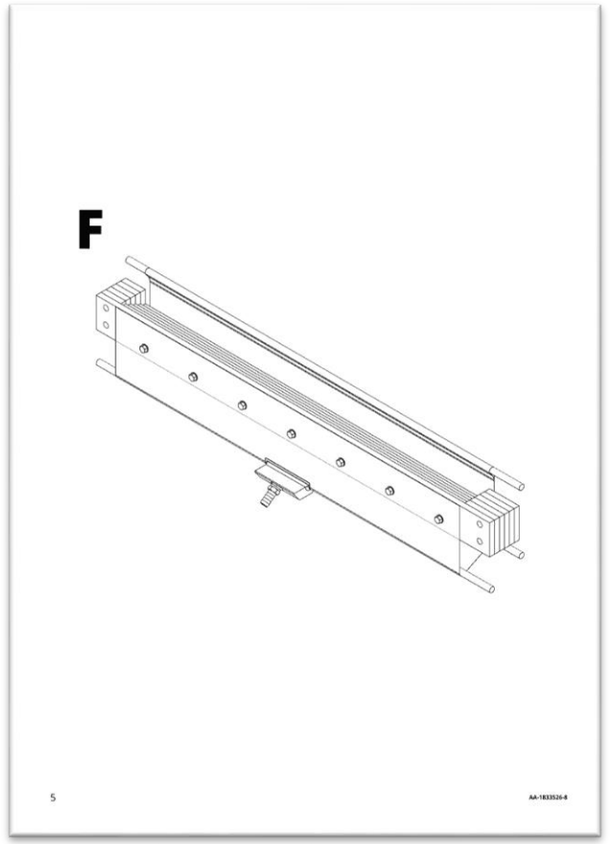










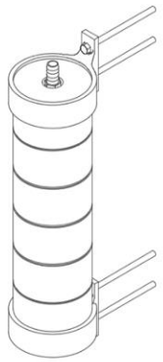


(66) Assembly Booklet Final Design Layout (Continued)

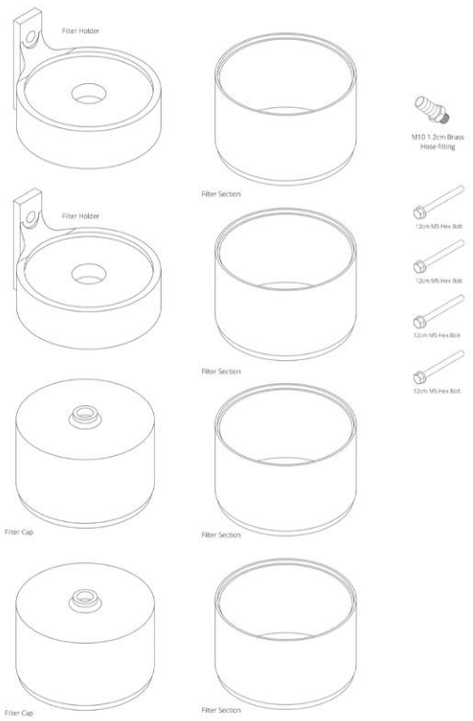
P3

FILTER ASSEMBLY

ASSEMBLY BOOKLET



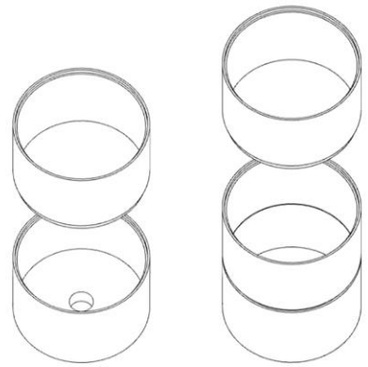
RESEARCH



2

AA-1833526-8

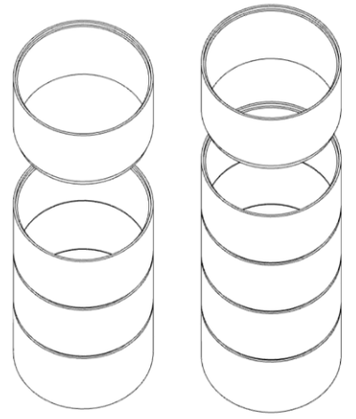
1



3

AA-1833526-8

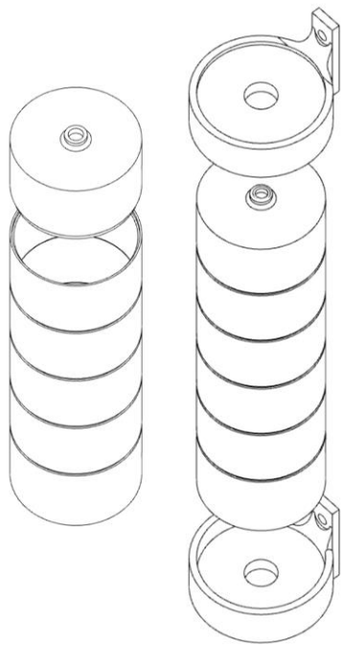
2



4

AA-1833526-8

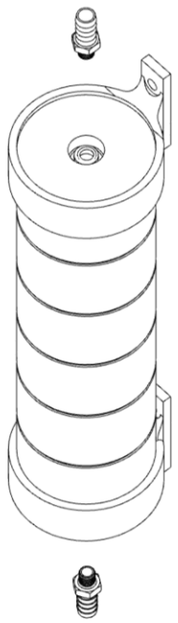
3



5

AA-1833526-8

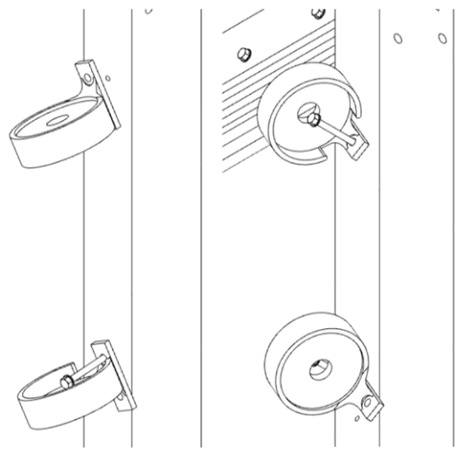
4



6

AA-1833526-8

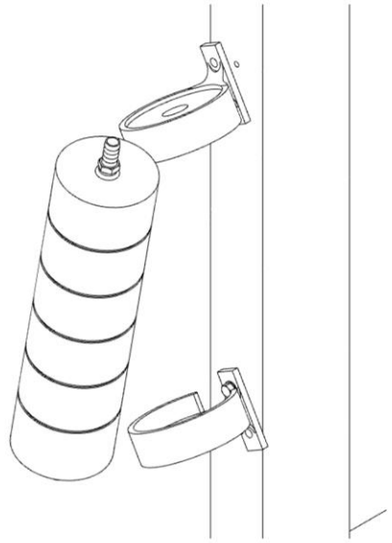
5



7

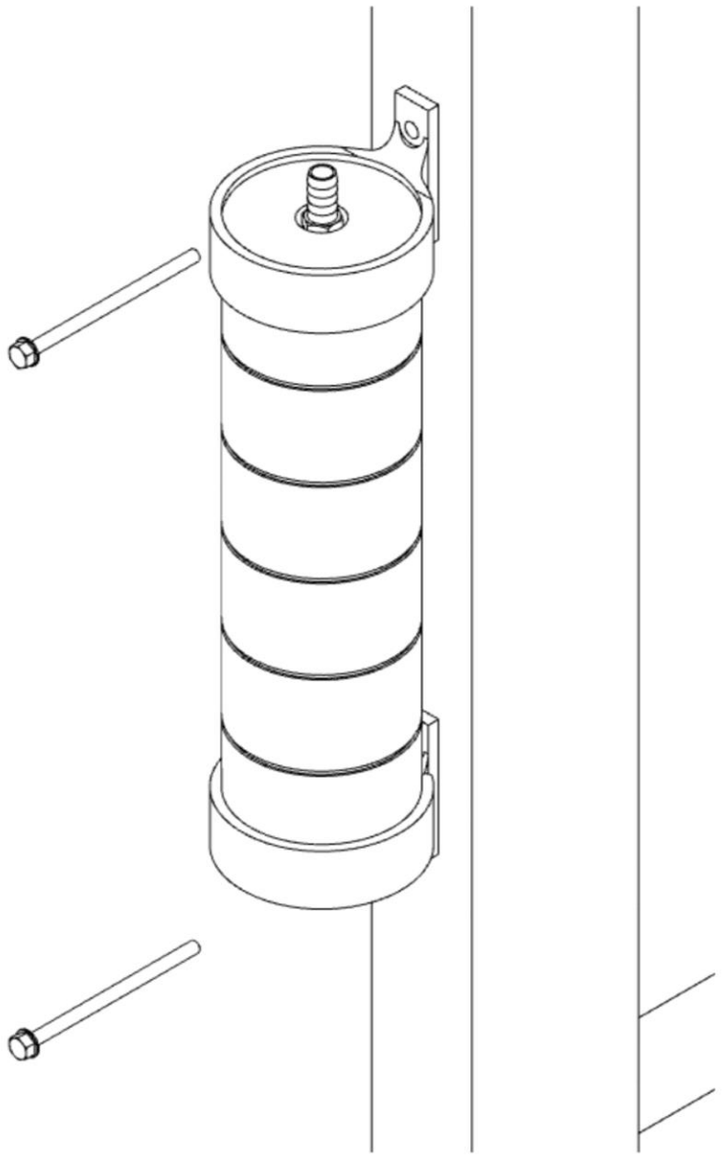
AA-1833526-8

6



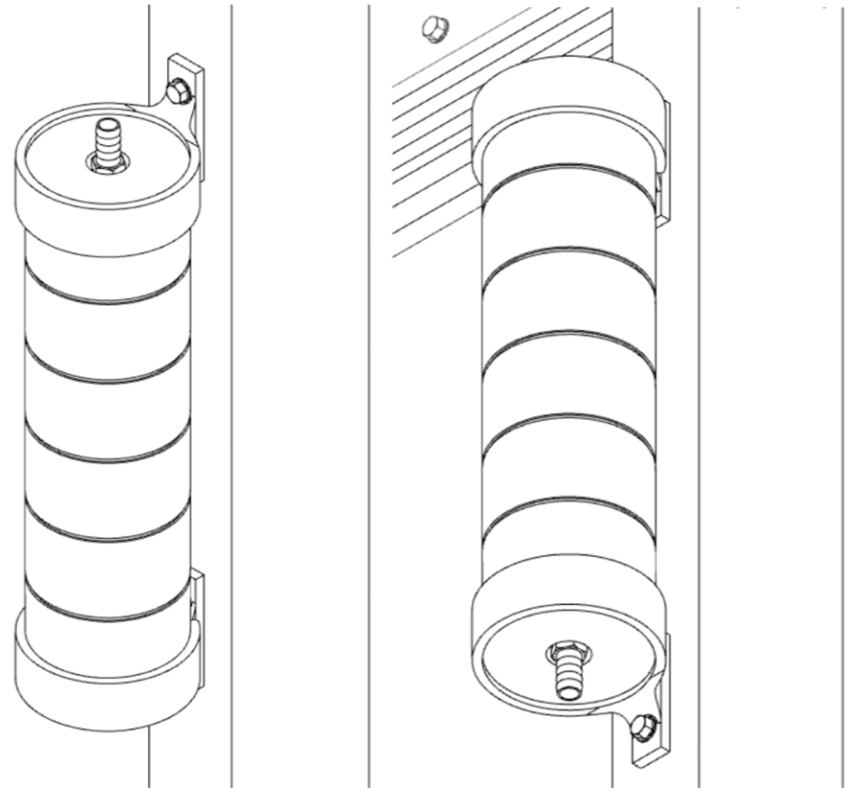
8

7



9

F



9

(68) Manufacturing Log

Key: General Information – Extra Information – Tools – Safety Points – Accuracy Points

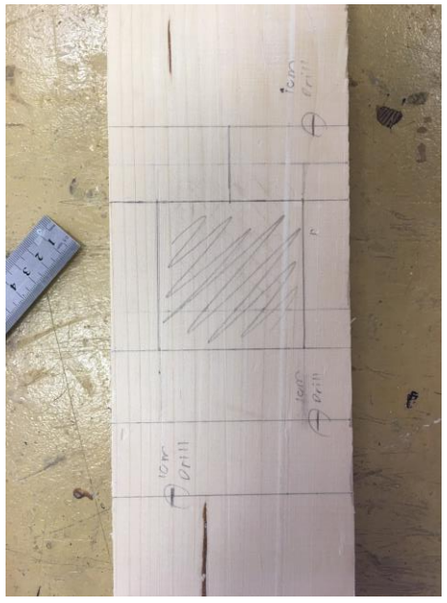
(1) Planeing down wood using the planner. For safety, I wore an apron, glasses, and had hearing protection. After each pass, the wood was measured to see if it matched our required thickness.

(2) Cutting wood into the correct widths using a table saw. For safety, I wore an apron, glasses, and had hearing protection. The cut for the wood was always marked so that the width of the blade was accounted for and so we cut on the outside of the marked line.

(3) Wood was cut using a Mitre saw into the correct lengths and was roughed up ready for lamination. During the use of the Mitre saw I wore an apron, and safety glasses. Again, the lines were marked so that the blade of the Mitre saw was accounted for and so we cut on the outside of the marked lines.

(4) Wood was laminated using wood glue and clamps. We used clamps to ensure the wood did not move during this process and so we would have a perfect joint. Sacrificial wood pieces were also used on the clamps with metal jaws to prevent damage to the wood during this.

(5) Here the wood is shown laminated, the two pieces are not inline as one length was slightly longer than the other, this was sanded downing using a rasp and then sanding blocks and sandpaper.



(6) Here the wood for the vertical support beams were marked with pencil to show where holes drilled and where a joint needs to be made. I used a ruler, a tape measure, pencil, and a carpentry square for this.

(7) Here the wood for both vertical beams has been marked. The carpentry square is shown on the top of the image.

(8) Here I am routering out the joint hole I have previously marked using a router. For safety I have worn an apron, and safety glasses. I Make sure not to go too close to the lines as this can be problematic later when chiseling, paring, and sanding out the holes.

(69) Manufacturing Log (Continued)

Key: General Information – Extra Information – Tools – Safety Points – Accuracy Points

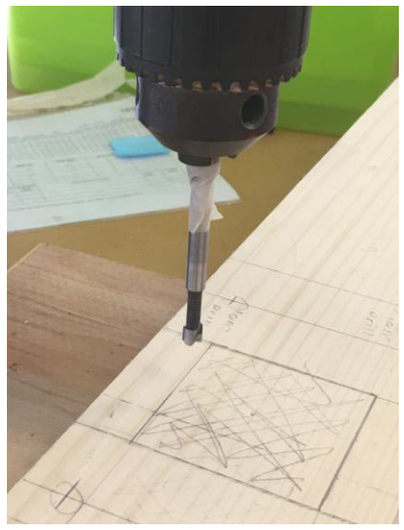
(9) This is the vertical support beam after routering, the same process was also repeated on the other side as this hole is a through hole. There are burn marks present due to a too high-speed setting and me not going back on my previously routed section to remove the packed sawdust this mistake was rectified on the other side.

(10) Here I am chiseling out remaining wood using a chisel. I make sure to point the chisel in parallel with the wood grain to prevent the wood from splitting at the corners of my hole. I also wear an apron and eye protection.

(11) Here is the wood piece after chiseling and some more routering to remove the final 3-5 mm of wood remaining. I used a router to router the remaining wood out, I also router the other side of the wood to leave a small layer of wood between the two faces which can be drilled and then chiseled out. I also made sure to wear an apron and eye protection.

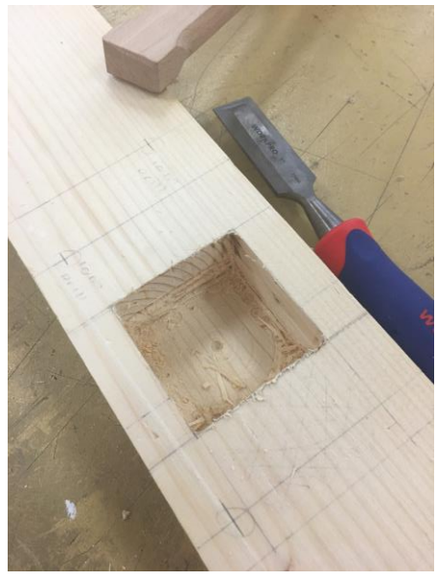
(12) Here is the finished piece after I used a Forstner bit on a pillar drill to drill out the remaining 10mm of wood between the two side, and the chiseled and paired the sides using a chisel. I made sure to wear an apron and safety glasses during both processes.

(13) This is the setup which I used to drill out the remaining wood in the previous step and chain drill in the next step. I have used different sized Forstner bits on this pillar drill. I have used a clamp on the end to act as a sort of pivot for the wood piece so that I can adjust the hole precisely.



(14) here I am using a smaller sized Forstner bit to chain drill a series of holes around the edge of the wood piece to make it easier to chisel out. I use a piece of tape to ensure I drill to the correct depth. Since this joint is not a through hole and only goes about halfway through the wood, I have to be careful to drill too far. I ensure to wear an apron and safety glasses during the operation.

(15) This is piece after chain drilling and then using a very large Forstner bit to drill out the center. I ensure to wear an apron and safety glasses during the operation.



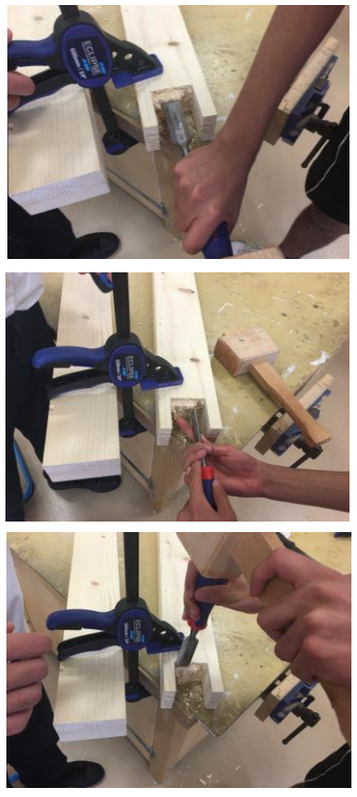
(16) This is the piece after chiseling and some paring of the wood. Here I again used a chisel and wooden mallet. Again, I ensure to wear an apron and safety glasses during this.

(70) Manufacturing Log (Continued)

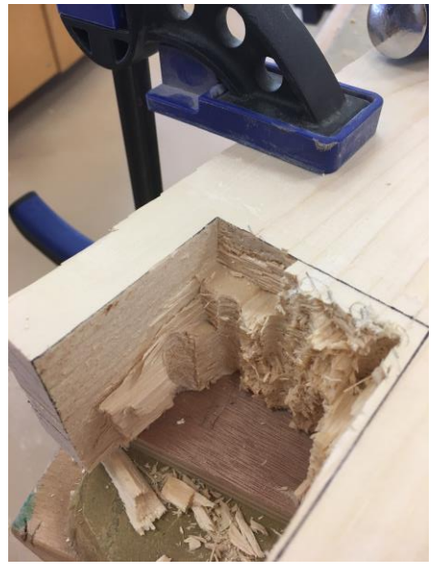
Key: General Information – Extra Information – Tools – Safety Points – Accuracy Points

(17) Here I am cutting the vertical support beam's other joint using a hand saw so that later it will be easier to chisel out the wood. I make sure to wear eye protection and an apron.

(18) After cutting the two slots using the hand saw, I drill out holes using a large and a small Forstner bit to reduce the amount of material that needs to be chiseled out. In ensure to clamp down the wood and hold it firmly when drilling to ensure accurate holes are drilled. I also wear eye protection and an apron.



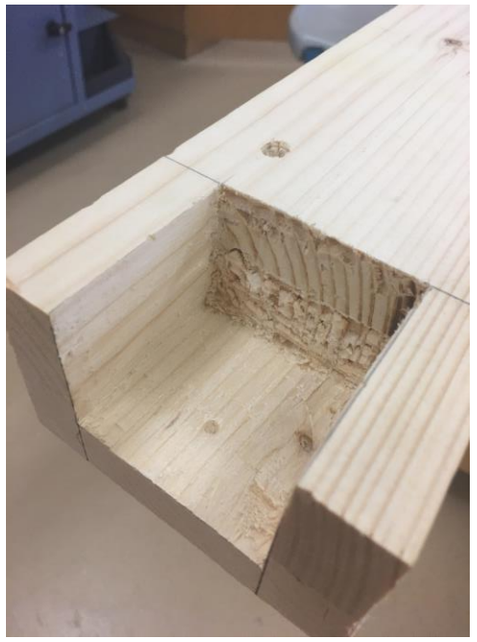
(19) After cutting drilling out the holes I chisel out the remaining wood in three different axis to reduce the amount of splintering as we are chiseling against the grain. I ensure to wear eye protection and an apron.



(20) Here is the joint partially finished and some pairing has been done.

(21) This is the finished joint after chiseling and some paring of the wood. Here I again used a chisel and wooden mallet. Again, I ensure to wear an apron and safety glasses during this.

(22) On the last joint I repeat the same process of using a large Forstner bit and chain drilling and then a chisel to remove the remaining wood out. I again ensure to wear and apron and eye protection during this. Here when drilling I drill a small amount and with every pass, I see how close I am to the final line.



(23) This is the finished joint after chiseling and some pairing of the wood.

(24) Here I am drilling out the holes for the wooden dowels (changed to steel rods). One side is a through hole whilst the other side is a partial hole, so I use tape again to make sure it goes the correct depth. I ensure I wear eye protection and an apron.

(71) Manufacturing Log (Continued)

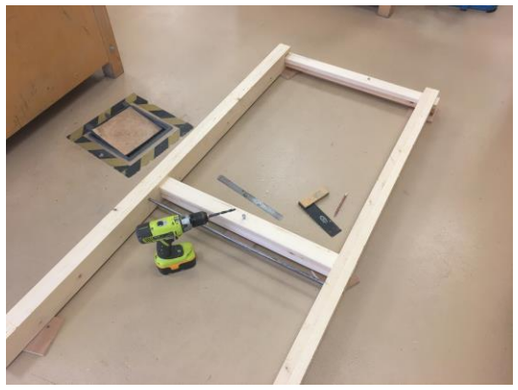
Key: General Information – Extra Information – Tools – Safety Points – Accuracy Points

(25) Here is the steel rods pushed into the holes drilled previously. A wooden mallet was used to push them in, and the holes were made slightly too small, so a very tight friction fit was made.

We have used steel rods instead of wooden dowels as we had none available to the correct length and diameter, this also resulted in a redesign of the 3D printed part as we were unable to cut the steel rod with the tools, we have available. This is why we were able to use the original funnel for the wood as a test piece for plastic welding.

(26) Here is the overall frame so far with the steel rods installed.

(27) Here the bottom horizontal support section has been hammered into the frame, again the fit was very tight due the holes being slightly under sized. The six section were also planed down to 9.5mm so that there would be space for the net to fit in between the sections. The section were hammered in using a wooden mallet and sacrificial wood pieces to make sure the wood was not damaged.



(28) Here I am preparing to drill out the holes for the screws in the horizontal support bar that will be used to clamp the net down tightly. I wear eye protection and an apron. I also place sacrificial wood pieces under the drill location to reduce splintering of the wood and to not damage the floor. I use a cordless drill with a M8 drill bit.

(29) Here I am tightening the bolt to the nut using a 10mm spanner and a flat head screwdriver. I take care not to over tighten the wood, so the metal "washer" does not damage the wood.

(30) Here I am cutting the extra length of bolt using a hacksaw. I ensure the nut is attached to the bolt when cutting to ensure I don't cut the bolt too short and also to ensure that I can push away the metal burrs and rough surfaces crated by cutting by running the bolt of the cut section to reestablish the thread.

(31) Here is the horizontal beam assembly after cutting the bolts.

I have used large M12 nuts as washers as we had no M5 washers available of the correct size.

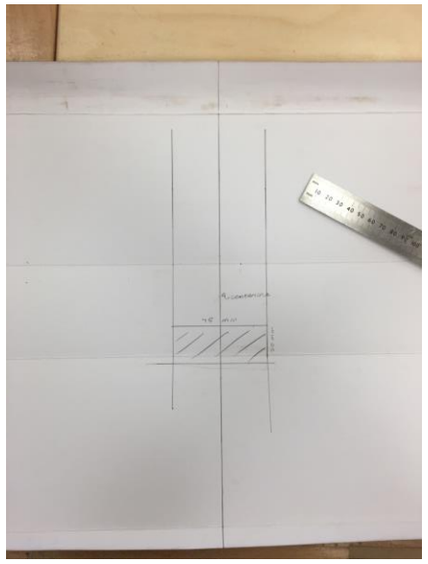
(32) Here I am creating a mockup to ensure that I have the correct measurements for the water catchment system. When cutting the cardboard using a craft knife, I use a safety ruler to make sure the blade does not slip, I also cut away from myself. We are using a mockup to account for the extra length required for plastic bends

We have decided to use plastic instead of tarp as we had no tarp available for use.

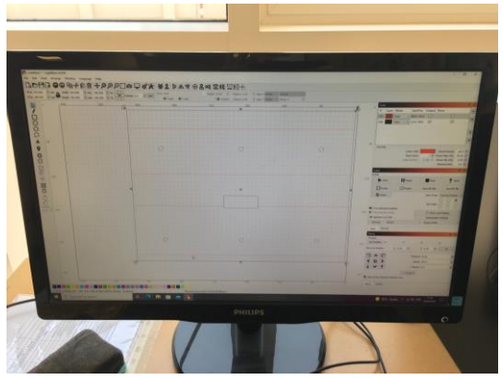
(72) Manufacturing Log (Continued)

Key: General Information – Extra Information – Tools – Safety Points – Accuracy Points

(33) After redesigning the piece in 2D Editor from the measurements from the mockup I laser cut the piece out on the laser cutter and double checked the lengths by reinstalling the piece.

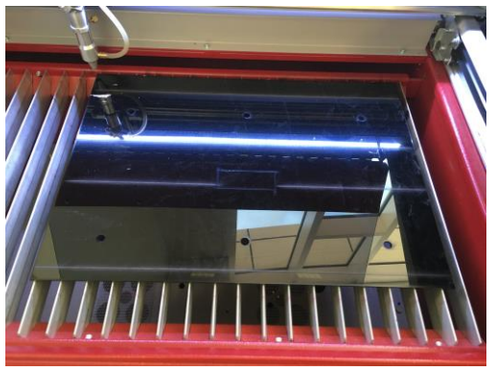


(34) Here I draw out the section that needs to be cut for the 3D printed funnel to fit into and I also mark out the holes required for the bolts in the horizontal assembly to slide through.



(35) Here is the LightBurn configuration for the laser cutter.

(36) Here I am inserting the plastic for laser cutting and engraving.



(37) Here is the finished piece after cutting and engraving. I have engraved lines so that the folds in the plastic are straighter and true, and also so that the fold is "convinced" to happen on the line rather than in other places due to the weakened structured of the line.

(38) Below is the setup for the acrylic bending. I ensure to wear gloves prevent burning myself with the heat gun. I heat one side of the acrylic using the line bender and since it is too small, I heat the remaining part using the heat gun. I use the scrap wood plank to bend the acrylic to the correct angle.

The acrylic here is red as it was later broken, and since I did not have any photos of assembling the black acrylic, I have to use these photos, however the process is the same for both the black and red acrylic.

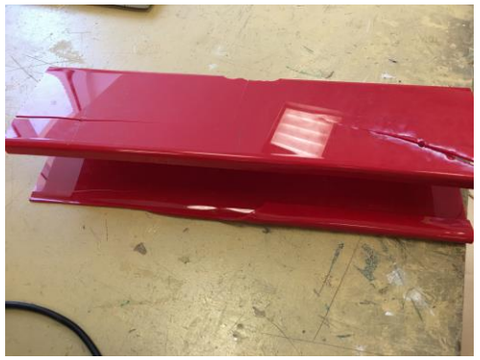
(39) Here I am heating the bend using the line bender, however since this bender is too small the right side of the bend will not be heated so at the same time, I use a heat gun to heat that side. I ensure to wear gloves for bending the acrylic into shape.

(40) Here I am bending the acrylic using the scrap wood piece. I wear gloves to prevent burning my fingers.

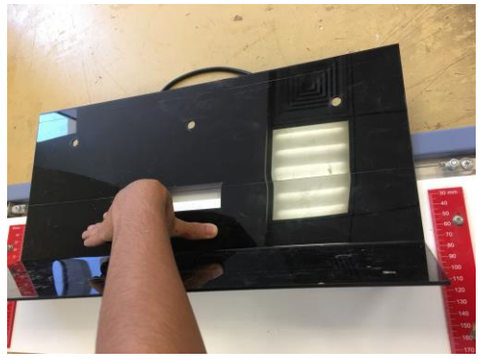
(73) Manufacturing Log (Continued)

Key: General Information – Extra Information – Tools – Safety Points – Accuracy Points

(41) Here is the water catchment system installed into the frame so that it can be further tuned used a heat gun and bent into the perfect shape. I again ensure to wear gloves during this to prevent burns.



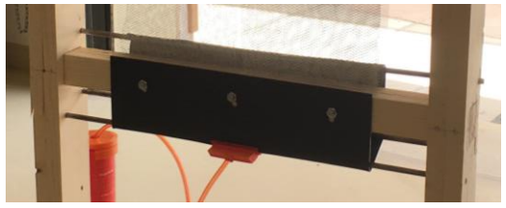
(42) Here acrylic piece has snapped due to not heating the entire piece and instead only heating the target area and pulling, this eventually caused stresses in the plastic causing a snap. We have tried using super glue to glue the two sections pack together to prevent wastage to no avail.



(43) I am again using the line bender with the black acrylic to reform the piece taking care not to snap it this time.

I have also reduced the length of the piece so that it more easily fits into the line bender as at this point, we were running out of time due to the limited manufacturing time.

(44) The reduced length would mean I could bend the piece without using the heat gun and so no gloves were required.



(45) Here is the final acrylic piece attached and bolted to the device.

(46) Here I am marking out the cut for the trench joint for the placeholder legs. I am using a marking gauge to mark the middle of the wood piece.

The piece is slightly different to the original CAD design as we did not have any timber available to the correct thickness.

(47) Here I am marking out the line and then the section that needs cutting using a pencil.

(48) Here I am cutting out slots in the trench joint using a hand saw. I ensure to wee eye protection and an apron. I also ensure not to cut too close to the line, and the slots will allow me to chisel out the trench more easily.

(74) Manufacturing Log (Continued)

Key: General Information – Extra Information – Tools – Safety Points – Accuracy Points

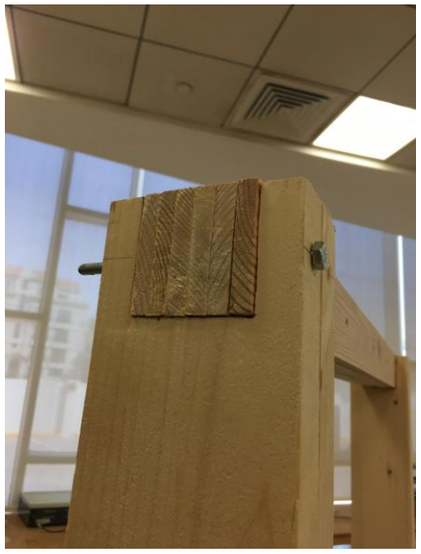
(49) Here I am chiseling out the joint using a wooden mallet and a chisel. I make sure to wear eye protection and an apron. I come back later and pair the joint using the chisel to ensure a perfect it.

(50) Here I am drilling out a pilot hole for the screw using a M3 drill bit and a cordless drill. I will then come back and use a Phillips bit and a cordless drill to screw the M5 screw in. I ensure I wear an apron and eye protection.

(51) Here is the finished trench joint.

(52) Here are both placeholder supports fastened to the bottom of the device.

(53) Here the top horizontal support section has been hammered into the frame, again the fit was very tight due the holes being made slightly under sized. The six section were also planed down to 9.5mm so that there would be space for the net to fit in between the sections. The section were hammered in using a wooden mallet and sacrificial wood pieces to make sure the wood was not damaged.



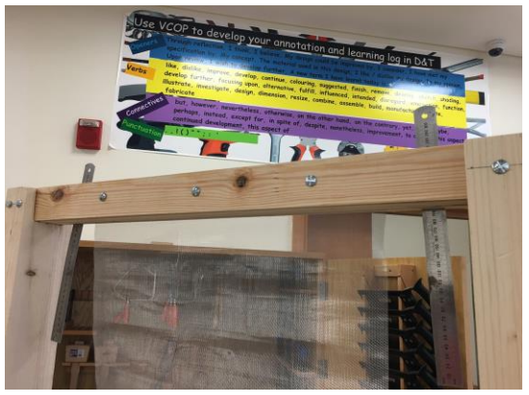
(54) Here using a cordless drill and an M8 drill bit holes were drilled for a through bolt to provide rigidity to the frame. I made sure I wore eye protect and an apron.

(55) Here I am using rulers as makeshift shims so that I can create space for the net to fit through during installation of the net. I wear gloves to prevent cutting myself on the sharp metal mesh net.

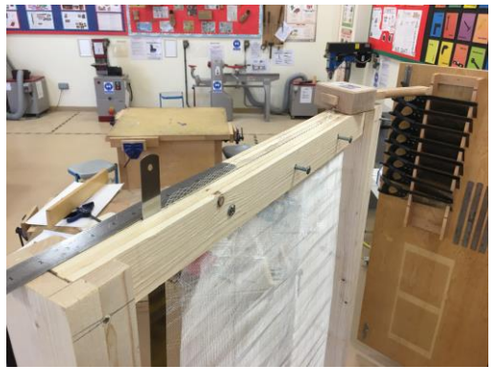
(56) Once the net has been installed, I force the bolts through the net to puncture it and create a hole using a wooden mallet.

(75) Manufacturing Log (Continued)

Key: General Information – Extra Information – Tools – Safety Points – Accuracy Points



(57) Here The bolts have been forces through and the frame is ready for the next net to be installed.



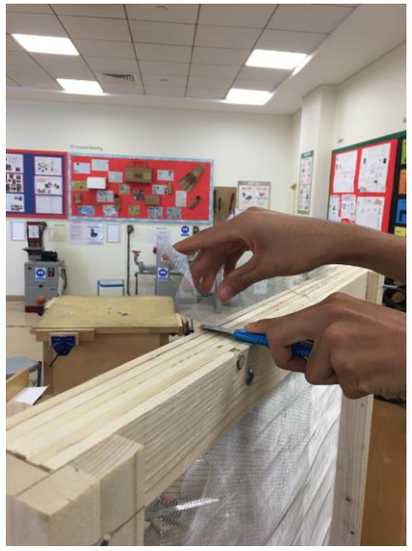
(58) Here the next net has been installed. The bolts are not all the way in to make room for the final net so that it can be installed

(59) Here is the second net installed, the second net is a coarser mesh than the first and second net.

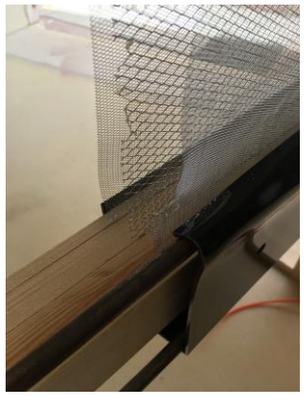
We also did not have enough mesh available to install all 5 nets, so hence only three nets are present.

(60) Here I am hammering the last bolts in for the final net using a wooden mallet.

(61) Here is the final net installed and ready for removing the excess mesh.

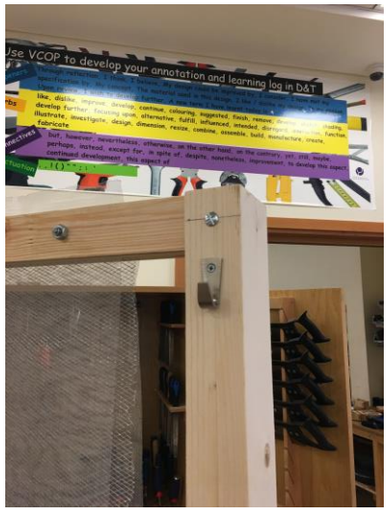


(62) Here I am cutting away the extra mesh from the top and bottom of the device using a craft knife, I make sure to cut away from myself



(63) Here is the final net after removing the extra mesh. There are three distinct layers, two fine and one coarse, they are all offset so there is no "easy" way for the water to go through.

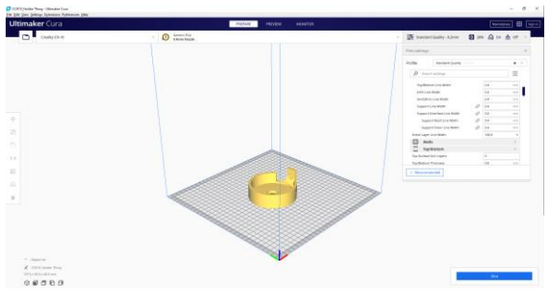
These nets are just placeholders as in the real design we would have used proper fishing nets of many different sizes to maximize the water catching ability.



(64) Using a Phillips head and a cordless drill I have also installed hooks on either side of the device to act as a simulation for if the device had proper ground mounding systems it would use a rope to also mount to the ground.

(76) Manufacturing Log (Continued)

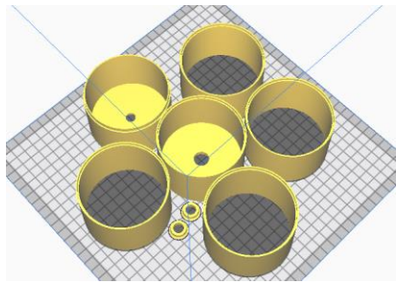
Key: General Information – Extra Information – Tools – Safety Points – Accuracy Points

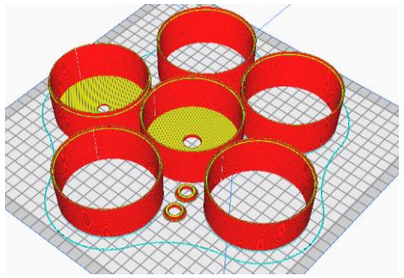


(65) Here is the Cura Slicer setup for the 3D printer, and below are the general settings for the following prints:

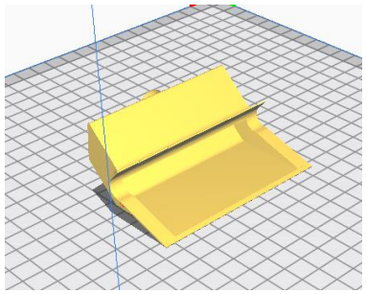
195 °C Hotend Temperature
60 °C Build Plate Temperature
95 mm/s Feedrate
0.3 Layer Height
No Supports
Infill at 25% and Cubic
Build Plate Adhesions is Skirt

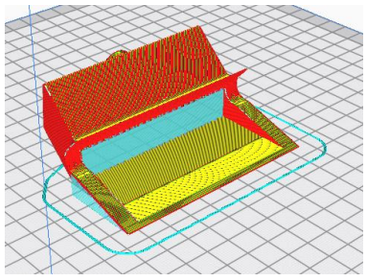
I printed the parts in PLA.



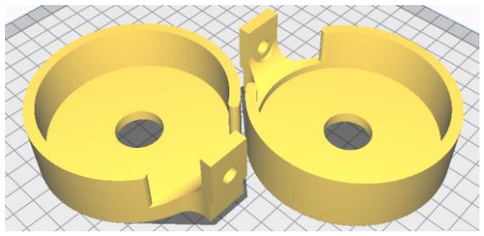


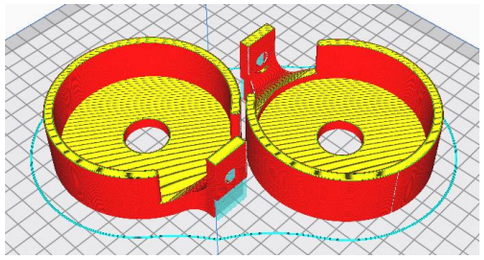
(66) This is print #1 and is a roughly 19 hour print. I have upped the feedrate on this print as the parts are quite simple to print and accuracy is not required.



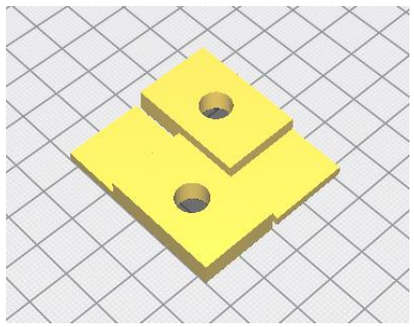


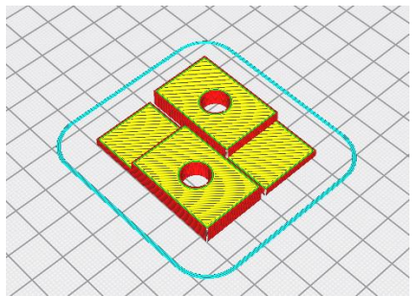
(67) This is print #2 and is a roughly 8 hour print. I have lowered the feedrate on this print as the part is quite complex and so accuracy is paramount.



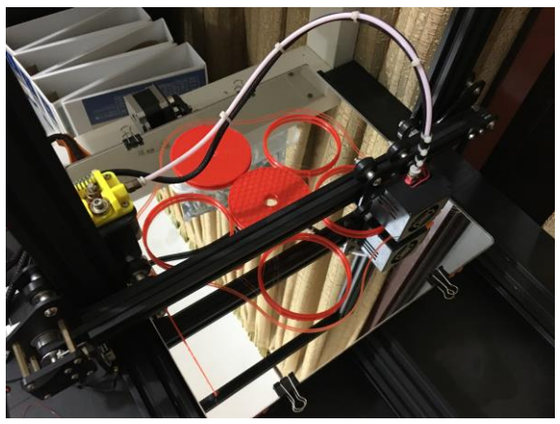


(68) This is print #3 and is a roughly 12 hour print. I have lowered the feedrate on this print as the part is quite complex and so accuracy is paramount.

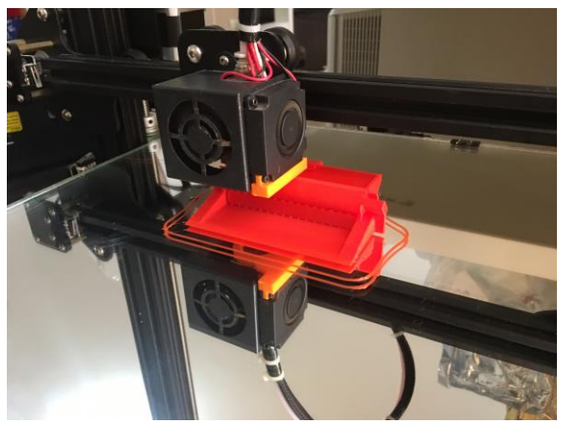




(69) This is print #4 and is a roughly 15 minute print.



(70) Here is print #1 in progress. For safety as the print is very long and was running over night I adjusted the marlin firmware of the 3D printer so that if any voltage ups or downs were detected and if the PID controlled temperature dropped even for a few seconds the printer would immediately shut itself off reducing the fire hazard of such a print.



(71) Here is print #2 in progress, to ensure accuracy in all prints I have made sure to lubricate the Z-axis lead screw and tighten all belts and POM wheels to ensure these is very little play in the axis.

(72) Here are the finished prints after sanding. I sanded all plastic pieces using sandpaper and blocks instead of mechanical sanders as the airborne plastic dust could cause a fire.

The color was initially red but during one of the prints I ran out of red PLA filament and so I switched over to orange PLA.

(77) Manufacturing Log (Continued)

Key: General Information – Extra Information – Tools – Safety Points – Accuracy Points

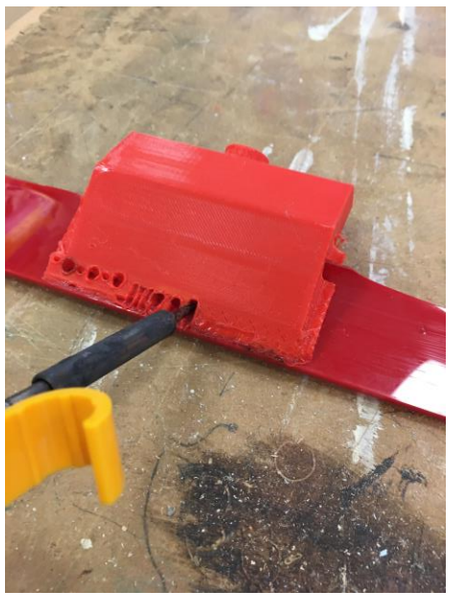
(73) Before installing the 3D printed parts I and down the whole device using an orbital sander in two sandpaper grits. I ensure to wear eye protection and an apron during this process.

(74) I first use a cordless drill and a Philips head to start the screwing process but then hand screw the rest of the way using a screwdriver to prevent the snapping of the plastic

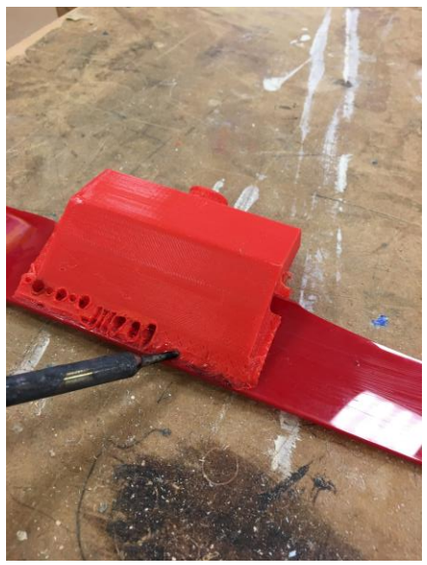
(75) Here we are using the old piece as a test to see what way we should plastic weld the piece to the acrylic. The red acrylic is from the snapped water catchment system.

As mentioned before this is the extra piece I have left over as we ended up using a steel rod instead of a wooden dowel, so I had to redesign the piece.

(76) Method #1: Here I am pushing the soldering iron into the PLA and then into the acrylic to form a sort of "drill hole" bond as the two plastics will mix together forming a stronger joint.



(77) Method #2: Here I am pushing the soldering iron sideways into the PLA to increase the area of the "drill hole" joint so that it is even stronger.



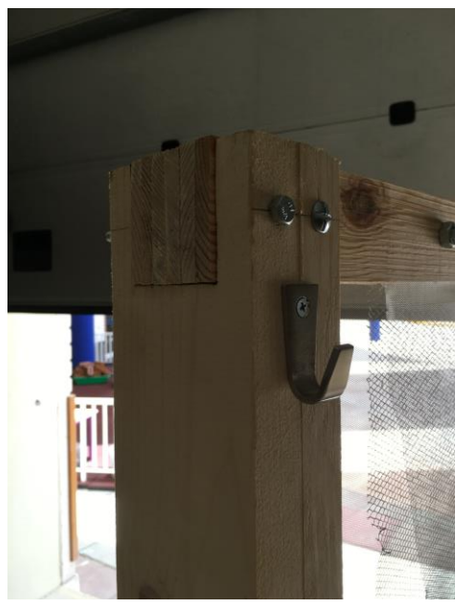
(78) Method #3: Here I am trying another method to just melt the surface to create a bond, this however wasn't as strong as the other two joints and so Method #2 was used.

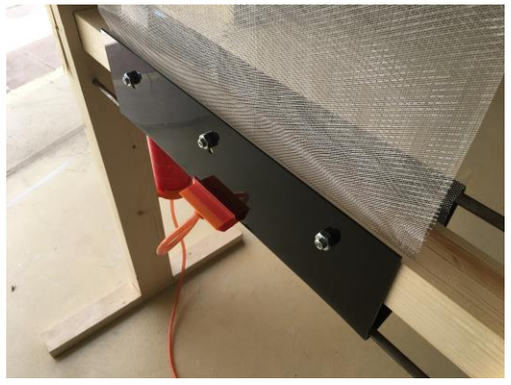
(79) Here is the final piece plastic welded onto the frame.

(80) Here is the final filter assembly assembled.

(78) Final Prototype

Below is the final water catcher in multiple angles, there are two main views, one being a type of panoramic view, and the other detail views of specific interest points:





(79) Evaluation (Peer and Client/User Testing)

Introduction:
In this part of the evaluation section, I plan to assess whether I have met my clients needs and wants, and test out the prototype.

Needs	Met / Partially Met / Failed	Wants	Met / Partially Met / Failed
Functionality- A product that will either help support him in drought or in floods.	Met, the prototype is able to provide water in periods of drought	Education- Perhaps including a book / booklet on how to operate the device properly, and why climate change is happening may be beneficial	Failed, there is no educational booklet included with the design.
Independent- The product should only be operated with one person, so that they are able to remain independent.	Met, the prototype does need to be operated by anyone.	Power- The product would preferably not be electrically powered, or at least not require electricity to complete its main function	Met, the design does not require any electricity to operate.
Cost- The cost of the product should be relatively low as Mr. Elimn is in the working class	Met, the prototype does not use and specialized or expensive materials.	Repairs- The product must be simple / have standardized parts to aid easy repairs in case they are needed.	Partially Met, the device has standardized nuts, bolts, nets, etc. but may be difficult to repair due to it not being as intuitive to use.
Sustainability- The product should contain materials that are sustainably sourced and can easily be recycled	Met, the prototype uses relatively common materials that can easily be recycled.	Materials- The product should preferably come in a kit so to reduce costs, and to make sure that the wood is sustainably sourced.	Met, the prototype comes in a kit meaning that it is compactly packed and so assembly is done on-site.

Figure 19.1

Figure 19.2

Figure 19.3

Water was poured over the net using a jug as we did not have a hose available in figure 11.1. This is also the reason why there is water on the floor in figure 11.3 as it is difficult to prevent too much water from flowing into the mesh.

As the water was poured it flowed down the mesh, and into the black catchment system, into the red funnel, down the red pipe, through the filter, and down into a collection cup at the bottom in figure 11.3.

Figure 11.2 shows the water collecting on the mesh as intended. The water will build up into small droplets and once heavy enough will fall down the mesh into the catchment system below.

Conclusion:
After completing this section of the evaluation, I have tested out the water catcher by pouring water over the catcher, and I have also asked questions to them regarding the prototype, both of these things will inform me when marking the prototype against the specification. Moreover, I now also understand if I have met the needs of my target demographic and if not I now know what areas need improving, weaknesses, and strengths.

Moving Forward:
In the next section of the evaluation I plan to mark the device against the specification and gauge how success the prototype is by allocating a final score.

(80) Evaluation (Specification Testing)

Introduction:
In this section of the evaluation, I plan to compare the water catcher prototype to my original design specification, this in turn will allow me to judge how successfully the prototype answered my design brief and specification and will also allow me to compile my findings in the strengths, weaknesses, and areas to improve table.

Area	Specification point	Met / Partially Met / Failed	Evaluation
Form	1.1a The product (when packaged compactly) should be smaller than 1.5 meter cubed. 1.2a The shape of the product should have ergonomic grips. 1.3a The aesthetics of the product should be complimentary to the local environment.	1.1b Met 1.2b Failed 1.3b Partially Met	1.1cAccording to the fusion 360 3D model, the device in total takes up 744700.553 cm^3 or 0.7447 m^3. If packaged compactly we can say that the product will take a maximum of 1.25 m3 and so it is safe to say that this criteria has been met 1.2c The product does not have an such grips and thus holding components like vertical support beams may be uncomfortable for long periods over difficult terrain. 1.3c This criteria has been partially met as in some environments it may blend it whilst in others it may. Since more vibrant colors and thus unnatural were used in the 3D printed parts and the acrylic it may not easily blend it, however these colors were used due to the material constraints we had and so if we had a wider range of colors available, we would be able to make the plastic pieces blend in more with the wood. The wood pieces however should blend in quite nicely in the surrounding areas and thus the criteria is partially met.
Function	2.1a The product must be able to complete its main function without mains electricity. 2.2a It could be modular / adaptable. 2.3a It must provide relief or support the chosen demographic from climate change. 2.4a It should act as innovative product to promote sustainable lifestyle among the community.	2.1b Met 2.2b Met 2.3b Partially Met 2.4b Partially Met	2.1c There are no electronic components involved in this prototype. 2.2c The prototype can be connected to other sections as shown in the working drawings and there are two sets of holes in the vertical support beam open type. This allows for either a single net, or more nets to be expanded onto the prototype depending on the user's requirements. 2.3c If the prototype was able to completely function (as the net we have used here is not fine enough) it would be able to provide relief to the chosen demographic as it would be able to provide the major resource of water, however since it is not fully functioning again due the availability of the mesh types I the workshop it is unable to catch large enough quantities of water to be functional. 2.4c The product does not contain an informative manual on climate change and thus cannot education the local community about this, however since the prototype provides a major resource and might be quite life changing communities with low water security, it may cause an interest in why such devices are needed.
User requirements	3.1a Should be easy to assemble, preferably with no specialist tools. (Design for assembly) 3.2a The product should also have a instruction manual 3.3a The product could have an educational guide on climate change 3.4a The product must be intuitive to use. 3.5a Instructions should be visual and language friendly.	3.1b Met 3.2b Met 3.3b Failed 3.4b Partially Met 3.5b Partially Met	3.1c The prototype only requires two tools, a Phillips screwdriver, and an M10 spanner. These two tools can be packaged with the prototype so that it can be assembled by communities that do not have such tools available. 3.2c The product contains a user manual. 3.3c The product does not contain an educational guide on climate change. 3.4c The product at first glance does not seem intuitive to use but after having people assembly and test out the working principle of the prototype it seems more intuitive to use especially after using the assembly booklet to assemble the product. Perhaps making the design seem more friendly and the booklet more intuitive may reduce the steepness of the learning curve. 3.5c The instruction booklet could be more language friendly as especially step 10A and 10B are quite confusing to figure out which step you will need to use as one is for a single net and the other is for a modular system. However other parts of the instruction booklet are quite intuitive as after having people assembly the prototype instructions could be easily followed.

(81) Evaluation (Specification Testing) (Continued)

Area	Specification point	Met / Partially Met / Failed	Testing
Performance requirements	4.1a Must be durable and survive extreme weathering. 4.2a Should be able to support its own weight. 4.3a The product should weight no more than 20kg.	4.1b Partially Met 4.2b Met 4.3b Met	4.1c According to previous FEA simulations the frame will be able to withstand the force as the frame did not crack at extremely high forces in a worst-case scenario. Moreover, the plastics will be able to survive the weather and harsh sunlight, however since the wood has not been varnished, we cannot say this criteria has been me 4.2c I can assembly the product and allow it to stand on its own for a few days, and then assess whether it is stable or not. 4.3c The device weighs in at 11.6 kg approximately.
Material and components	5.1a Must include non-permanent joints for easily assembly and disassembly. (Design for assembly) (Design for Disassembly) 5.2a Materials should have properties that are relevant and make sure the product is easy to assemble (Design for processing) (Design for assembly) 5.3a The product should include standardized parts to aid easy repair and reduce costs.	5.1b Met 5.2b Met 5.3b Met	5.1c The product does not contain any glued components, except the two plastic parts where they are plasticly welded, this however is not a problem as if this product was properly produced these two parts would be one component. 5.2 The stiff nature of the net makes it easy to insert into the horizontal support bars and, since everything has a tight fit the parts do not require that much fastening and thus the assembly process is relatively easily. Moreover wood, metal, and plastics are quite common materials and so are easy to process in the factory. 5.3cThe product contains only metric screws, nuts, bolts, etc. It also contains standardized metal bars and meshes. The wood also has no "awkward" sizes and all holes are similarly sized.
Scale of production and Cost	6.1a The product could be mass produced. 6.2a The product could be batch produced. 6.3a The prototype should have simple design, and include ideas such as snap-fit (Design for assembly)	6.1b --- 6.2b --- 6.3b Partially met	6.1c This criteria cannot be assessed. 6.2c This criteria cannot be assessed. 6.3c This criteria is partially met as although it has some complex components the overall process of assembly for the end user is quite simple and the exact design working idea behind pieces do not need to be known by the end user. However, the design is quite easy to assemble as there are only 6 major joints, two of which are just screw in, the remaining two slot it, and the last two slide in.
Sustainability	7.1a Materials must be sustainably sourced. 7.2a Materials and components must be ethically sourced and produced. 7.3a The materials should be easy to recycle using a lack of adhesive and more non-permanent joinery methods. (Design for disassembly) 7.4a The product must be long lasting	7.1b Met 7.2b Partially Met 7.3b Met 7.4b Partially Met	7.1c The wood used in this project was sourced sustainably by my school, and in the final product again the wood will be sourced sustainably. 7.2c I am unable to assess whether the components I have used in the workshop have been produced ethically, however in the final product I will ensure that all components are sourced ethically. 7.3c The prototype contains only 4 materials, steel, pine, acrylic, and PLA, this means Recyling is quite simple and easy. Moreover, there are no permanent joinery methods except the two plastic parts where they are plasticly welded, this however is not a problem as if this product was properly produced these two parts would be one component. 7.3c Most components in the design are over engineered and too much material has been used meaning that they do not easily break, however since the wood has not been varnished, we cannot be certain if the wood will not rot or degrade.

The total score of this prototype is calculated through a met criteria equaling 2 points, a partially met criteria 1 points, and a failed criteria 0 points.

Total Score	Max. Score	Final Comments
33	46	Overall, a score of 32/46 or a percentage of 72% is the worst-case scenario as some criteria I have just barely not met.

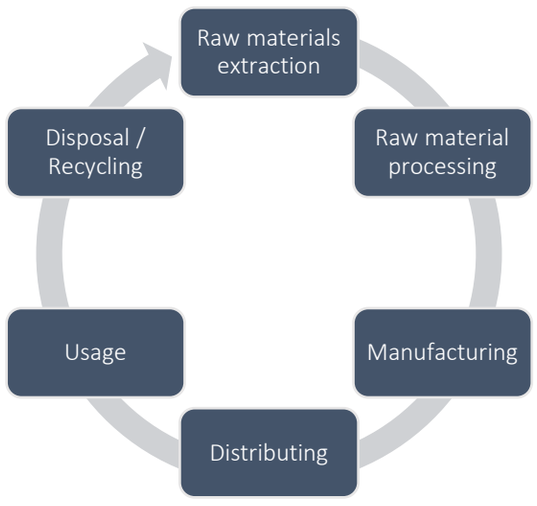
Conclusion:
After completing this section of the evaluation, I have now graded the prototype against the specification allowing me to determine any major shortcomings of the prototype and thus address them in the areas to improve. Moreover, I have also identified areas of success allowing me to reflect back on the prototype as a whole.

Moving Forward:
In the next section of the evaluation, I plan to complete a full life cycle analysis of the prototype which will again help me determine and shortcomings of the protype which will then be addressed in the strengths, weaknesses, and areas to improve page.

(82) Evaluation (Life Cycle Analysis)

Introduction:
In this section I plan to analyze the lifecycle of the final water catcher, I will talk about raw material extraction, material processing, manufacturing, distributing, usage, and disposal / recycling. This in turn will allow me to compile my findings in the strengths, weaknesses, and areas to develop table thus allowing me to assess to what degree the prototype I have designed and built succeeded.

Stages of the lifetime of the water catcher:



Raw materials extraction:
The major materials of the water catcher are: pine, acrylic, and PLA

1) Pine
   Pine wood is extracted from the environment through large forestry machinery which cut down pine forests. The branches are then chopped off and made it wood chips and both the chips and logs are sent to the sawmill using trucks. This process is sometimes highly un-environmentally friendly as it firstly can destroy habitats, contribute towards global warming, contribute towards reduced air quality, desertification, and reduced soil quality. The wood for prototype should be only used if it is sustainably and ethically extracted. Moreover, shipping the wood from the lumber site to the sawmill may cause a large carbon footprint.

1) Acrylic
   Acrylic is made from the polymerization of organic chemicals such as alkenes extracted from crude oil. Making plastics requires a lot of energy as to extract any useful compounds from crude oil it has to go through the process of fractional distillation where different sections of a fractionating tower are heated at different temperatures to separate the fractions (compounds) according to their boiling points. This large amount of energy may come from non-renewable sources which damage the environment such as coal.

2) PLA or Polylactic acid is a plastic made from the fermentation of starch from corn, cassava, maize, sugarcane or sugar beet pulp. Enzymes are used here and they anaerobically respire to form lactic acid and through polymerization is made into Polylactic acid plastics. This is much greener for the environment as no energy hungry fractionation needs to happen and thus the carbon footprint of PLA is much lower than Acrylic.

Raw materials processing:

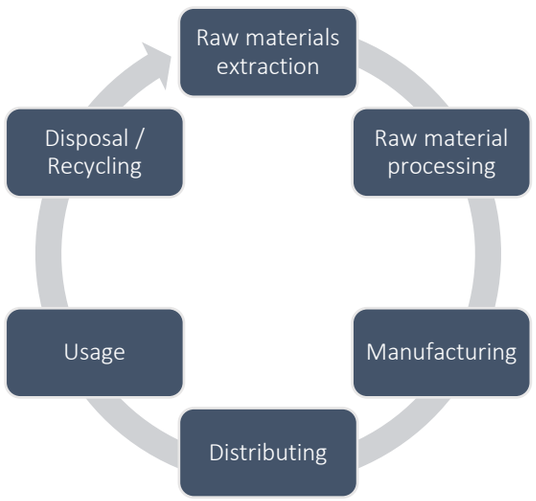
1) Wood
   The logs are marked and then cut by machinery into dowels, planks, boards, sheets, veneers, etc. And the chips are either made into chipboard or made into saw dust and then into MDF.

2) Acrylic
   Here the plastic pellets made by the plastic factories are sent to the various manufactories and melted down to form boards, pipes, etc.

3) PLA
   Here the plastic pellets are sent to 3D printer filament producers where it is heated and then passed through a thin dye to create a very long continuous strand of plastic which is then wound along spools for usage. This 3D printing process is highly inefficient as plastic pellets are sent from the plastic factory to the 3d filament factory to be reheated and then sent to homes and commercial spaces for 3D printing and then again reheated. This involves a lot of shipping and reheating, and this thus causes a large carbon footprint.

(83) Evaluation (Life Cycle Analysis) (Continued)

Stages of the lifetime of the water catcher:



Manufacturing:
There is no real manufacturing phase of this prototype as it will mostly be assembled on site. The net is most likely die cut from a sheet of metal, the screws and nuts are machined on an industrial scale. This means that economies of scale are exploited and thus the bolts and nuts are produced very efficiently.

Distributing:
The prototype will be transported to many regions in the world, the product has been designed with lightweight-ness in mind, as it uses a lightweight plastics, and pine which is a lightweight wood compared to the rest of the woods due to its relatively low density. This means that it does not require large amounts fossil fuels to be spent moving the product around the world. The product will also be unpacked and will be assembled on-site meaning that its package is relatively small, thus reducing the carbon footprint of said product, as the product will compacted into a small package.

Usage:
If varnished prototype is built to be long-lasting meaning that it will most likely not have to be recycled and will continue to be repaired throughout its lifetime, and when it finally reaches the end of its life it will need to be recycled. The product will be exposed to the elements almost daily, including harsh weather, cold, heat, etc.

Disposal / Recycling:
The product is composed of mostly rudimentary materials meaning that it will be easy to recycle.

The acrylic and PLA are very common plastics thus meaning they are easily melted down to make new products, and if the plastic become too old then PLA can be decomposed in an industrial composter or burned in an incinerator very cleanly as it uses no toxic chemicals. However if acrylic becomes too old and cannot be recycled then if burned it will produced toxic gases, and cannot be composed due to its inert nature.

The wood is easily recycled as it can be used to create chipboard, MDF, etc. or can be used in other projects such as house framing.

Conclusion:
After completing this page of the evaluation, I have an understanding of the lifecycle of my prototype, and thus the shortcomings in this process. This will allow me to improve the prototype and define areas for improvement in the strengths, weaknesses, and areas to improve table.

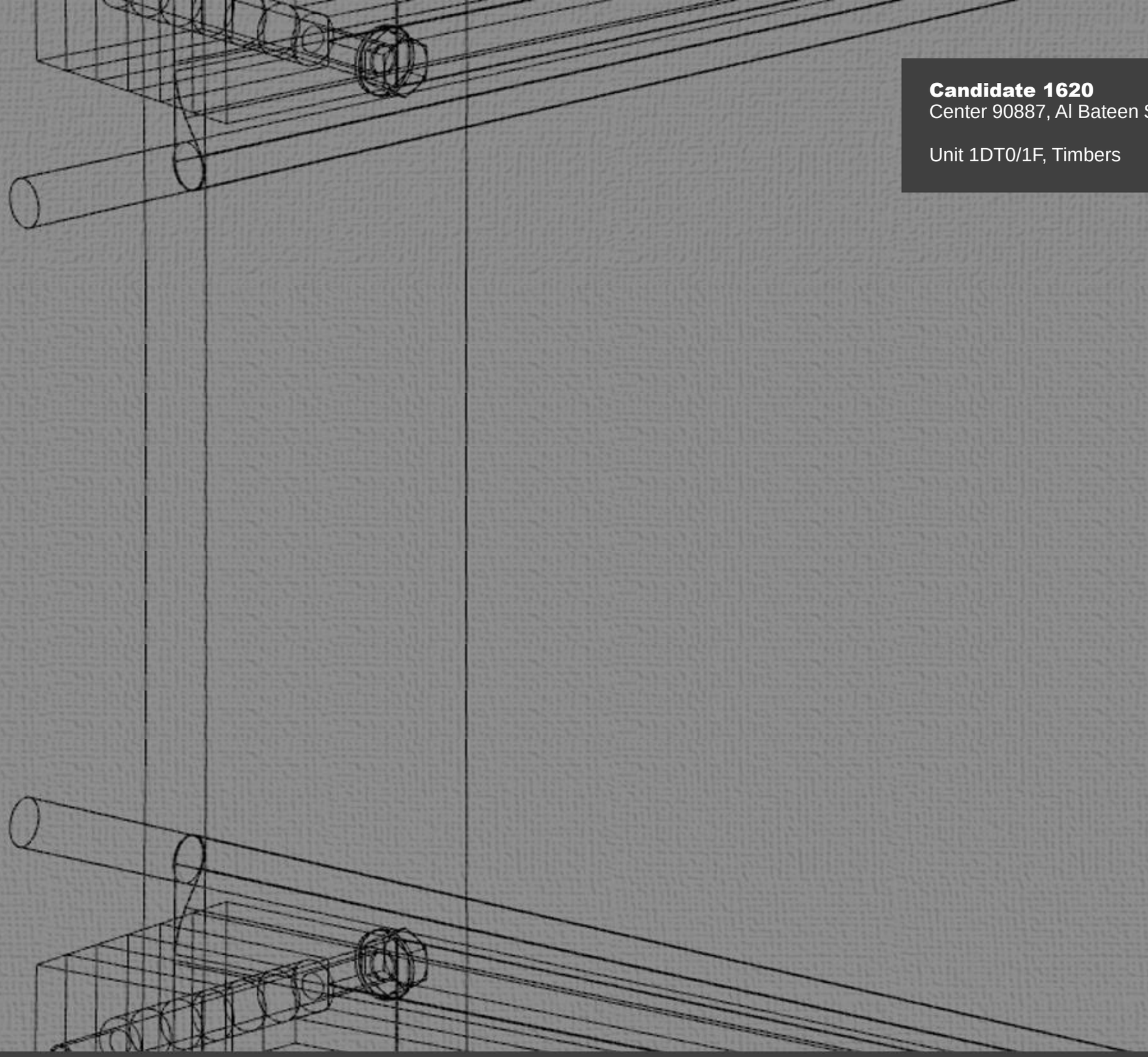
Moving Forward:
Next, I plan to compile all my findings form the evaluation into one page and thus gauge how overall successful (if at all) my prototype was.

(84) Evaluation (Strengths, Weaknesses, Areas to Develop Table)

Introduction:
In this final section of the evaluation, I plan to compile all my previous findings into one table where I am able to gauge how successful my project is in a final conclusion. I will detail the strengths, weaknesses, and areas to develop for the prototype modular water catcher.

Strengths	Weaknesses	Areas to Develop
The design is modular and adaptable meaning it's capacity can be increased as needed, or as the community grows. No concrete must be poured for the foundation of the catcher meaning costs are reduced. No specialist tools are required as mostly everything using nuts and bolts, and so no tools other than a M10 spanner and Philips screwdriver are required. The design uses materials that are long lasting and so the device will not need repairs reducing costs and raising service life. The prototype when packaged compactly is able to fit in a volume of 1.5 meters cubed. The design does not require electricity to function. The design contains an assembly booklet to aid first-time users in assembly. The design weighs no more than 20kg, and can support its own weight. The design contains non-permanent joinery methods The design contains standardized parts for easy repairs and reduced costs. Materials used to produce the prototype are sustainably sourced. The prototype once it has reached the end of its life is easy to recycle.	(1) The design does not have any ergonomic grips (2) The design is not completely intuitive to use and may require prior knowledge to operate. (3) Throughout the year the direction and abundance of low-lying cloud cover changes and so the catcher may need to be moved, this is a problem as the catcher (without the placeholder legs) would be mounted very firmly to the ground. (4) The design does not easily blend in to the surrounding environment. (5) There is no education booklet on climate change, and so the prototype may be unable to promote a sustainable lifestyle among the community is supports. (6) The net is not completely functional and so the device cannot completely provide relief to the chosen demographic. (7) The prototype needs to be varnished to ensure it is long lasting and thus requires little to no repairs. (8) The acrylic plastic is although recyclable, is very un-environmentally friendly as it burns to produce highly toxic gases and does not decompose easily. (9) Use more efficient processes, as currently the carbon footprint of the prototype is quite high.	(1) The design could contain ergonomic grips to ease the burden when carrying over large distances in difficult terrain in remote areas, this will thus increase the reach of the prototype and thus it's impact on helping people. Research anthrometric data, and ergonomical design to further improve this aspect. (2) Change the design or include extra information to make the design more intuitive to use. Perhaps including an additional user manual on top of the instruction and climate change booklet may be beneficial. Also adding labels to the product, itself may help aid assembly. Moreover making the assembly booklet more language friendly by simplifying steps 10A and 10B may help too. Research IKEA instruction manuals and their design constructs. (3) Find a compromise between stability and movement for the design as during the year it may need to be moved. (4) The colours used in the acrylic and PLA should be changed to more muted colours such as dark greens, blues, reds, and browns. Research colours that are quite muted and considered natural from studies. (5) An educational booklet could help promote a sustainable lifestyle in the community and thus provide more water security, food security etc. through good practices. Research and then design education booklets and climate change. (6) Further research nets and find common nets that can be used to catch water effectively without being too costly. Test out potential candidates and record water volume collected per unit of time. (7) Varnish the prototype and research other methods of protecting wood. (8) Switch over to PLA, or perhaps research a new plastic instead of PLA for both the 3D printed pieces and acrylic instead. (9) Use injection moulding for the plastic parts as 3D printing is very inefficient due to shipping and reheating the plastic. Perhaps research newer processes to replace injection moulding. Moreover use mass production to reduce the carbon footprint per unit as things are shipped in bulk.

Final Conclusion of the Prototype Modular Water Catcher:
After completing this final section of the evaluation I have now identified the strengths weaknesses, and areas to develop the prototype modular water catcher. If in the future I decide to continue with this project I have outlined points that I need to address firstly in the second prototype of this project. Moreover, I am able to reflect back on the strengths and weaknesses of the design and thus reflect back on any improvements I could make during my design pipeline. Final statement on next page:



Candidate 1620
Center 90887, Al Bateen Secondary School

Unit 1DT0/1F, Timbers

*'Overall, as a first prototype with limited resources available and many delays due to the pandemic I believe that the Modular Water Catcher Prototype can be considered as a **relative success**.'*